The Petroleum Engineer

ALL DIVISIONS
• Exploration Drilling and Production
• Refining and Gas Processing
• Oil and Gas Pipelining

MAY, 1950 • VOLUME XXII • NUMBER 5

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Oil Exploration Groups Widen Boundaries

The American Association of Petroleum Geologists, the Society of Economic Paleontologists and Mineralogists, and the Society of Exploration Geophysicists held their annual meeting in Chicago last month. This meeting was of special significance and importance to the domestic oil industry for two reasons. First, for the symposium on Possible Future Oil Provinces of North America and second, for the special session devoted to a broad consideration and discussion of reefs.

"In 1941 this Association (the AAPG) under the guidance of the capable hands and generative mind of A. I. Levorsen published its first symposium on 'Possible Future Oil Provinces of the United States and Canada'. Since that time there have been many significant developments that have affected our Association, our potential provinces, the status of our industry with respect to our country, and our world. Our Association has doubled in membership. Our industry has vigorously explored in many of the provinces included in that first symposium and has developed new geological data and discovered new and important hydrocarbon reserves. Through these exploration efforts the unprecedented demands of a war and a cold war have been and are being adequately met as have the cries of 'exhausted reserves' heard from those without the industry. These developments suggested the appropriateness of a second such symposium—a second inventory of our 'undiscovered oil (hydrocarbon) resources and our philosophy of discovery.' The area has been increased to cover all North America. It is anticipated that our industry and our Association membership, both old and new, will derive material benefit from this presentation."

In the 1941 syposium no consideration was given to the continental shelf as a possible future oil province, nor were the possibilities of reefs recognized or considered. These are two important additions to our thinking in the matter of possible future oil reserves.

Recognition by the formidable scientific group of how our outlook on possible future oil provinces has broadened geologically and geographically in the short space of nine years is an encouraging and healthy sign. The vigorous manner in which this subject is being attacked lends assurance that great domestic reserves of petroleum and natural gas still await discovery. This is a comforting thought in these times of critical world tensions.

At the joint session on reefs, six papers were read, including a progress report on Devonian Reef Exploration in Canada. The titles of these papers reveal the broad intensive study now being made on reefs: Paleogeographic Distribution and Classification of Reefs; Some Physical Aspects of Ancient Reef Complexes; Regional Discussion of Pennsylvanian Reefs of Texas; Structure-Forming Role of Limestone Reefs in Eastern Platform Area of West Texas; and Geology and Geophysics of North Snyder Area, Scurry County, Texas.

It is a significant fact that "some reef fields have produced for many years but most of the fields and most of the reef information were developed since 1946. Pennsylvanian reefs in Texas now account for eight major fields and more than twenty of less importance."

Our progress in oil exploration is a tribute to the high degree of cooperation that exists between the three groups, the AAPG, the SEPM, and the SEG, in whose capable hands the exploratory activities of the industry rest. K. C. S.

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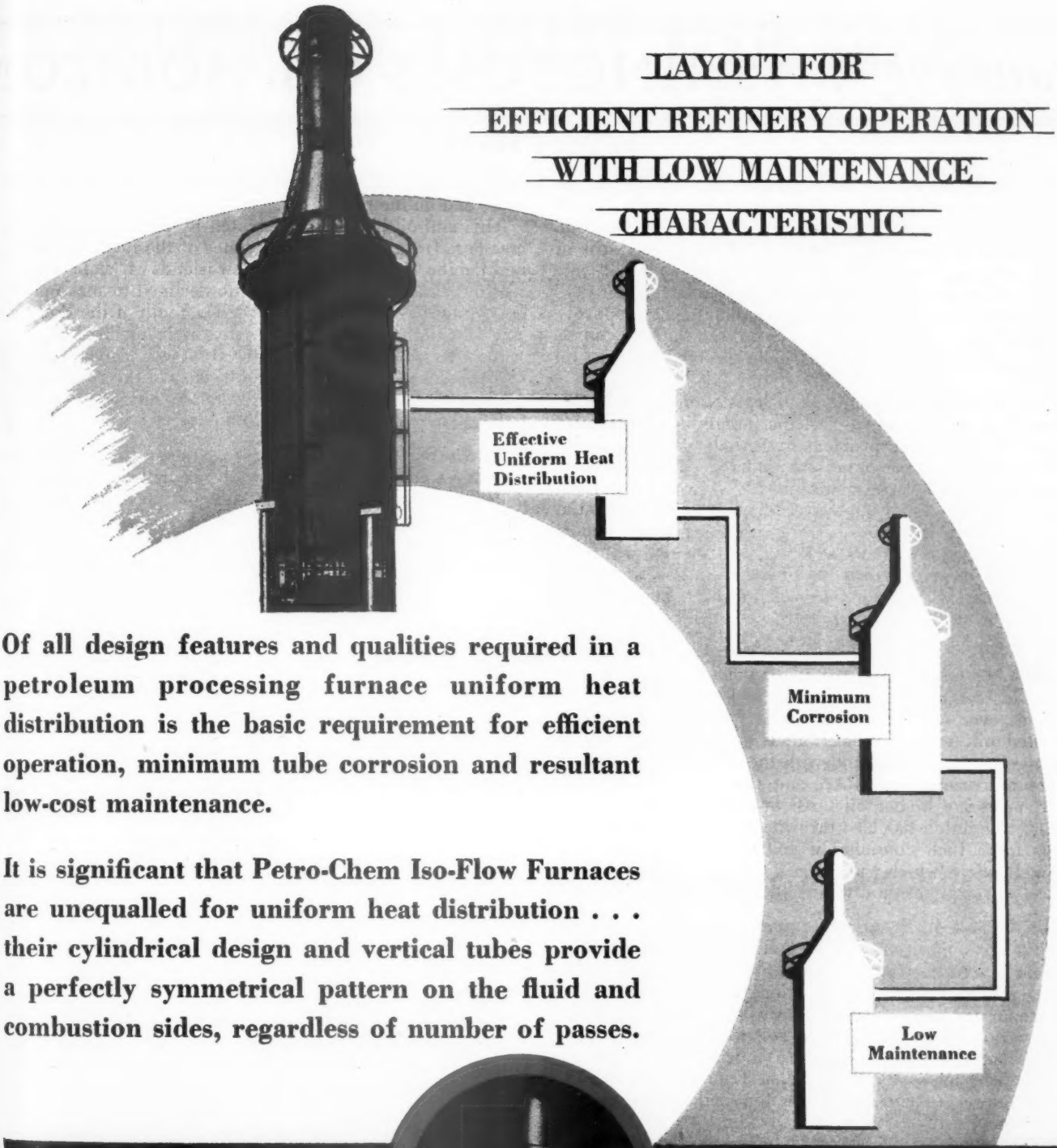

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Scanning WASHINGTON'S OIL HORIZON

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WASHINGTON—President Truman's decision to do something about the oil import situation was the "silver lining" of storm clouds developing over the Kerr Gas Bill.

Oil states congressmen, including Speaker Rayburn of Texas, visiting the White House after the gas bill veto sensed an anxiety to placate them for Truman's "run out" on what they had regarded as a firm commitment to approve the bill. These congressmen quickly pressed their advantage and suggested that presidential action be taken against oil imports.

Since Rayburn was opposed to legislation for a higher oil tariff or for import quotas, the possibilities of a short range solution of the problem narrowed down to "voluntary" cutbacks by the importers, spurred on by "or else" threats from high official quarters.

Interior Secretary Chapman and other top presidential advisers believe that the answer to the long range import problem, like many others involving petroleum, will have to come from an overall study of coal, oil, gas, and other forms of energy and their inter-relationships. Such a study would form the basis for the government developing a national policy on fuels and their uses.

UMW Moves In. One reason for the intensified interest in limiting oil imports was the activities of the coal people, worried over coal's displacement by oil—particularly imported oil. John L. Lewis' mine workers union joined with the coal operators, and with the independent oil producers represented by IPAA and the coal-carrying railroads, to seek a higher oil tariff or legislation for import quotas. The union has also thrown its support behind proposals for a fuels commission and the development of a national policy "which will place in their proper perspective coal, oil, natural gas, and water power."

Gas. Tip-off on President Truman's switch on the Kerr Gas Bill was opposition to it by Mon C. Wallgren, developing just before the veto. Wallgren, newest member of the Federal Power Commission, is a long time personal friend of Truman and can be expected always to reflect his chief's attitude. So, it appears that a 3-to-2 majority of the FPC is now ready to put the spurs to independent producers since the veto message indicated that Truman believes FPC has the power to control production and gathering and expects them to exercise it in controlling prices. It was a personal memo by Secretary Chapman to the President, however, which tipped the scales in favor of a veto.

NPC. Jumping so quickly to the defense of the Oil and Gas Division in the Interior Department, the oil industry may have prevented—for the moment, at least—elimination of this focal point for government-industry cooperation. But the highly placed foes of OGD won't rest until they have rid the government of this petroleum unit, which is staffed entirely with men from the industry. With OGD—its government counterpart—gone, oil leaders fear that the National Petroleum Council would wither on the vine.

Anti-Oil Bloc. One aftermath of the fight over the Kerr Gas Bill was the development of an anti-oil bloc in Congress, which may threaten any future legislation favored by the petroleum industry, if it doesn't succeed in putting over oil controls of one kind or another. It was inevitable that the perennial oil critics should gang up on the first important oil issue—the Kerr Bill—to come before Congress for a vote in the past decade. Amazingly, this nucleus was quickly fanned into a near-majority by hostile commentators in the press and on the radio.

This anti-oil bloc, as represented by the voting, includes members from the consuming states of the East, Mid-West, and Pacific Coast (except for a few islands of "states rights" sentiment among Republicans who declined to make political capital by opposing the gas bill). South of the Potomac and west to the California line, most were for the bill.

Next time, however, the opposition will concentrate its efforts on consumers in the non-oil states of the South whose members, generally, traditionally stand their ground against federal encroachment on any industry.

Synthetic Fuels. Secretary Chapman has given the industry a chance to make good on its criticism of the estimated costs of synthetic fuels put out by the Bureau of Mines, requesting the National Petroleum Council to make a study of such costs as compared with fuels made from natural petroleum. Chapman said the Bureau's experimental work was sufficiently advanced so that it "would now welcome a critical study of its cost data by the NPC and will cooperate fully in furnishing data for such a study."

Another Probe? Oil has a long time critic—Senator Gillette of Iowa—as well as a staunch defender—Senator Schoeppel of Kansas—on the newly appointed Senate Small Business Committee. Absent from the list is Senator Wherry of Nebraska, who was chairman of the committee in the 80th Congress and filed one of the most critical reports on oil in history. This report was largely the work of Paul Hadlick, Wherry's oil counsel. Hadlick is now associated with Gillette on the agricultural committee. If an oil subcommittee is set up again, Gillette likely will head it, which would mean that Hadlick could have his old job back again, if he wants it. Hadlick still is counsel for the National Oil Marketers Association and, as such, initiated the Madison oil cases 15 years ago. It is significant that Gillette has sponsored a bill to reprint a thousand copies of the Wherry Oil Report.

Tidelands. Speaker Rayburn has assured sponsors of the new tidelands quitclaim bill that it will come up for a vote this session. Congressman Gossett of Texas, who piloted it through the House Judiciary Committee, is confident that it will pass the House despite violent opposition from the chairman and nine other members of this committee who joined in a sharply worded minority report against it. The new quitclaimer would affirm state title to submerged lands for three miles out or to their historic boundaries (for Texas, it would be 10½ miles out). Beyond this marginal belt, the federal government would have jurisdiction but the states would receive 37½ per cent of the royalties. The Secretary of the Interior would be instructed to exchange a federal lease for any valid state lease issued prior to January 1, 1949.

G&G Ruling. Internal Revenue Bureau has issued a ruling (IT 4006) stating that geological and geophysical costs constitute capital expenditures and are not deductible as business expense—but the IRB has neglected to point out that it will permit expensing such items provided the taxpayer is willing to make certain changes in his accounting methods, which will be listed by IRB in response to an inquiry by an interested taxpayer. The IRB announcement came out after the deadline, March 31, however, to make such a change for 1950.

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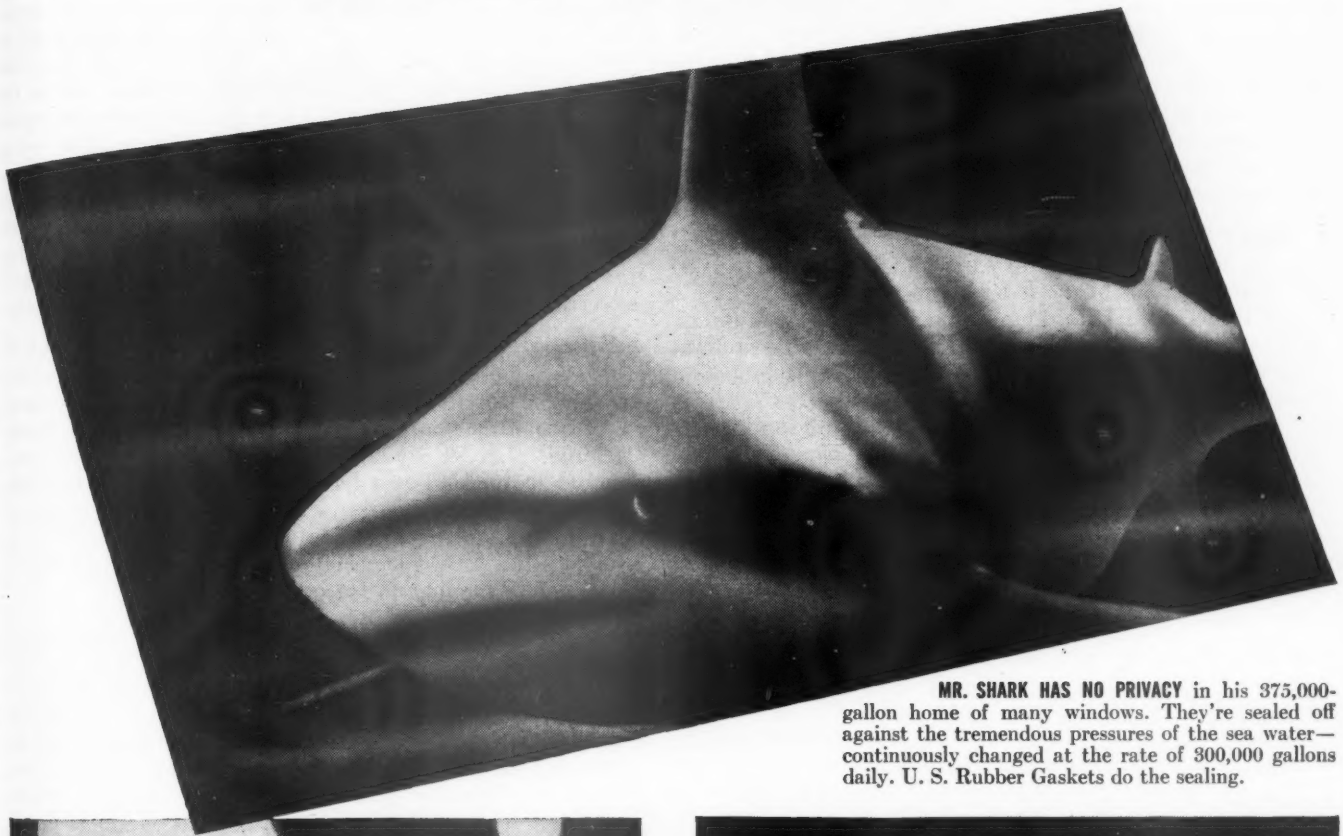

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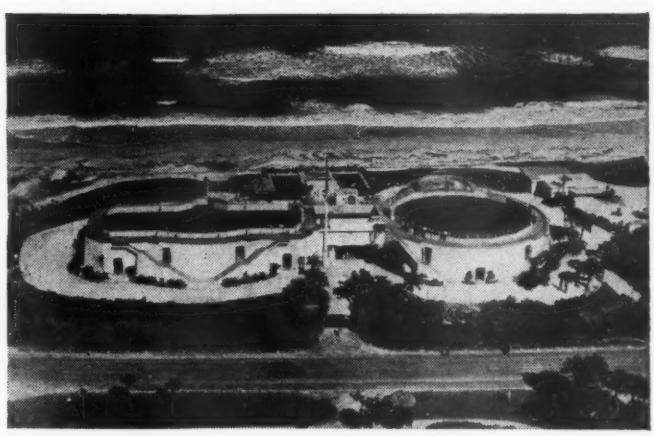

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Highlights in Oildom

Kerr Bill Veto Met With Disfavor. President Truman's veto of the Kerr bill was met with shocked dismay by members of the oil industry, who expressed the fear that Federal Government would seek greater control over gas and oil production. Oil producers had backed the Kerr bill in an effort to prevent the Federal Power Commission's regulating output and price of gas at the well. Although the FPC has never been actually delegated this power, a law passed by Congress specifically stating that such power is not held by the commission was felt necessary by oil men.

"Don't Compete Hard," Advises Expert. The best way for a large company to exist under current anti-trust law interpretations of the federal government apparently is not to let its right hand know what its left hand is doing, M. A. Adelman, economist from Massachusetts Institute of Technology, said in an address before the 47th semi-annual meeting of the National Petroleum Association.

"The safest motto for an integrated company appears to be: (1) hire a good lawyer, (2) hire a bad accountant, and (3) don't compete hard. Don't let your own self know what the various subdivisions of your business are doing, for that means that they are subsidizing each other."

Adelman added it must be concluded from government action that size is dangerous and, although there are exceptions to the rule, the attack is usually on large corporations.

British Tourists Get More Gasoline. Gasoline allowance for United States and Canadian motorists touring Britain has been almost quadrupled. Fuel Minister Philip Noel-Baker has announced that Americans and Canadians who bring their own cars to Britain or buy them there can get enough gasoline for 3000 miles of touring in their first month's stay, enough for 2000 miles in the second month, and enough for 1000 in the third. Present limit is 1000 miles the first month, 300 the second, and 300 the third. British motorists are allowed 180 miles a month.

Labor Union Sued for Breach of Contract. The Texas Company has filed two suits against the Oil Workers International (CIO), totaling $1,605,000. The Beaumont, Texas suit claims the walkout at the company's Port Arthur and Port Neches, Texas plants was a breach of contract and agreement. The Chicago, Illinois suit claimed the union called a strike before expiration of a 60-day strike notice. Named in the suits as defendants were both local officers of the union and the labor organization's international officers who maintain headquarters in Denver, Colorado.

In answer to the company's claim, O. A. Knight, president of the CIO, stated that the union struck "in full compliance with the Taft-Hartley law and with the National Labor Relations board regulations," adding that the company was given due notice of termination of its contracts.

Federal Bureaus Invade Oil, O'Hara Warns. Federal bureaus and departments are seeking to obtain indirectly powers that have been denied by the Congress, Donald C. O'Hara, staff attorney of the National Petroleum Association, has charged. In a speech before NPA he cited instances of efforts by the Department of Labor, the Federal Power Commission, and the Federal Trade Commission to increase their powers without complete Congressional review. He warned industry that "much as Congress is maligned, our chances of getting fair treatment are better when all sides of a question are open to debate on Capitol Hill than when action is taken quietly by a bureau to extend its power."

Increased Oil Burner Sales Foreseen. A sales gain of 20 per cent is foreseen in the oil burner industry by leading spokesmen in the business. According to recent estimates, the industry will sell about 700,000 central heating units in 1950, compared with estimates of 650,000 made late last year. If the estimates prove to be correct, 1950 will be the biggest year in the industry's history. Estimates for space heater sales are also higher for the coming year. The industry expects over a million units will be sold before 1951.

Contributing to the general upward trend of business during 1950 are the disturbances in the coal industry that have existed through the entire heating season. Another reason is believed to be an increased and more effective advertising program, and post-war sales training programs.

Competition Belies Monopoly Charge. The snowballing growth of competition is proof in itself that the petroleum industry is anything but a monopoly, Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana) declared in an NPA address. Wilson pointed out that competition in the mid-west has cut his company to less than 20 per cent of the business in its marketing area, compared with 85 or more per cent in 1902. Even so, he added, the company has grown tremendously because of the amazing expansion of the market for petroleum products.

Venezuela Trade Position Favorable. Venezuela will be able to compete favorably in world oil markets with other big producing centers of the globe, Manuel R. Egana, secretary of the Venezuelan Department of Development, contends. Speaking before a group of government and industry people in Caracas, Egana expressed the opinion that British and American governments will reach an agreement on the problem of the British cut in imports of American oil.

Egana stated that the problems facing his country's oil industry include increasing competition from oil produced in the Middle East, increased production in western Canada, British restrictions on oil imports, and proposed restrictions on oil imports into the U. S.

Mississippians Denounce Imports. Seventeen witnesses, including Governor Fielding Wright, presented testimony before a sub-committee of the House Small Business committee, which recently held a hearing in Jackson, Mississippi to determine effects of excessive oil imports on that state. Rees R. Oliver, indepedendent oil operator of Jackson, stated that the state tax structure and general economy has been badly damaged by a loss of market to foreign oil, and added that the search for and development of new Mississippi fields "will be retarded for years if something isn't done about imports." As a result of increasing imports, Oliver told the sub-committee, Mississippi produced 7,743,000 less barrels of oil in 1949 than in 1948.

Russell Sees Danger of Socialist State Looming. America will have no one to blame but itself, should its people awake one day and find themselves without individual freedom as citizens of a socialist state, J. H. Russell, vice president of Gulf Oil Corporation and Gulf Refining Company warned more than 800 oil and gas men recently. Speaking before the opening of the 25th southwestern gas measurement short course, college of engineering, University of Oklahoma, he urged men and women of the petroleum industry to fulfill the responsibility their industry bears toward its country, by banding together to lead fellow citizens out of chaos.

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PETROLIC PERSONALITIES

DICK SNEDDON

Off to the Eastern Deserts

One of the things that make the petroleum industry forever interesting is that besides being ordinarily peopled by an amazing diversity of human kind, it also sporadically attracts to itself new members of infinite and astonishing variety. In the course of years of circulation around the hydrocarbon circuit, we have met many persons who have just suddenly severed themselves from other—often wholly remunerative pursuits—and have cast themselves into the petrolic maelstrom with real zest and without apparently the slightest compunction. Of such is one Duward Ryon, a short, stocky, rugged-looking chap with a sort of bashful smile, whom we had the brief pleasure of meeting down at Brown Drilling Company's modern Long Beach office, just before he left by plane for the Kuwait-Saudi Arabian neutral zone. He was listed on the manifest as a derrick man, but we learn that he has since been promoted to assistant driller.

Anyway, Duward, or *Doughbelly*, as he is rudely called by his buddies, came to the derrick groves by a distinctly circuitous route. He was born in Duncan, Oklahoma, the birthplace of many a stout oil artisan, but in the beginning would have none of it. Horses were his mania, and mark you, we mean handling them, not betting on them. It first began to show up when at the age of four he received from his dad a Shetland pony, on which he literally lived for the next five years, thus acquiring the cowpoke complex that was to dominate his life for some time to come.

Old Paint's Pal

By way of adding to his experience and saddle savvy, Duward took to calf riding and roping in the pastures, and soon had graduated to higher and more spirited horses. He knew they were more spirited because they bucked, and he knew they were higher because when they bucked he hit the ground harder. Thus, before he quite knew what had happened he had developed into a top ranking bronco buster and was in open competition with the best of them. A fondness for good food and a tendency to show it halted his career temporarily and earned him that sobriquet—Doughbelly, but it didn't stop him for long.

According to the record, about this time he bought a quarter horse, sight unseen, for $1500. Why he didn't buy a whole horse we'll never know, but nonetheless this fractional equine got him back in the mood again, and next thing we hear he is out on another equestrian binge—making money, too. He made all the big time shows, including Madison Square Garden, New York; Pendleton Roundup, Oregon; Cheyenne Rodeo, Wyoming; and the Calgary Stampede up in Canada, for several years. He has ridden the toughest hosses that ever busted a cinch, but he has been thrown oftener than a preliminary wrestler, and for a while his bones were doing so much knitting he took up the study of needlecraft.

Rounds Up at Derrick

Eventually, having licked all the fractious broncos to a frazzle and left himself no further equine worlds to conquer, Duward turned for further adventure to that almost equally rugged species of enterprise—petroleum, particularly the drilling part of it, and has been so zealous in his efforts during the past few years that he is now regarded not only as a top operator, but also as a pretty swell joe. That's the thing that counts in the oil business, that "swell joe"appellation.

Dali Shirts and Salvatori

The upper crust of New York petrolic society has been shaken to its delicate core by the sudden return of Bill Farrand from the West Coast, dressed in a shirt that resembles nothing in this world excepting perhaps a post-impressionist circus poster. This highly articulate garment has more colors in it than a Honolulu sunset, but the predominant hues are lurid greens, reds, and yellows, and the better scandal gatherers contend that it was purchased as a defence against the emanations from some of George Trembley's ultra-violent creations.

We had heard from one of our Mid-Continent operatives early in April that the Farrand entourage was seen streaking westward in a big new Cadillac that looked as if it were jet propelled, and had been mistakenly reported a couple of times as a flying saucer. A short time after that we discovered the Fire Chief veep himself scouting around the Los Angeles Petroleum Club in a frantic search for golf pigeons. However, by dint of sheer mental control he managed to sit down long enough to have lunch and recite his cross country adventures to Henry Salvatori, the Western Geophysical prexy, and Grant Oil Tool Company's much traveled Jerry Engstrand.

The Man With a Stance

Immediately thereafter, he scurried out to the Wilshire Country Club and crossed eight-irons with Walter Hagen Trembley and Art Sneed Moyer, a pair of fairway sharpies who have found a lot of oil on the local links. What the meteorologists cited the next morning as one of the worst Santyanas in a decade was in reality this trio attempting to move a sand trap out on to the course. Bill's visit, so the story goes, was largely designed to recover his lost stance and swing, which had disappeared almost entirely during the winter solstice, and there is no question that he did get some of it back, for we are told that before he left to return to good old Broadway, he had played every golf club on the Pacific strip. In fairness, we should mention that he took enough time out from belting the ball into the ground to help Paul Huggins celebrate his son's birthday party, and to enjoy some of the fine hosting of the Cy Rubels. This latter adventure, by the way, certainly sharpened up his pitch game, and we herewith issue a solemn warning to the Manhattan Islanders not to engage him in a high, low, jack tussle unless they are well supplied with the long green.

Also out to the Coast on a business trip recently was Al Martin, a Gulf Oil Company legal light from the thriving city of Houston, Texas. We spotted Al being piloted around various oil men's retreats by his Western associates, Jim Leovy, Tom Wallace, Glen Ledingham, Paul Broxon, and sundry other Gulf biggies.

The Deer With a No-Point Antler

We understand that Barrister Martin in his leisure moments is given to fishing and hunting in the lesser traveled reaches of his home territory, and is quite the nimrod. We always envy a man who really knows the art of stalking game animals, being ourself so hopelessly inept. We went out once with a group of oil men deer hunting and after walking for miles and miles, our high powered rifle weighed

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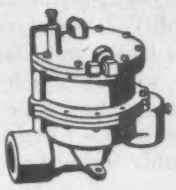
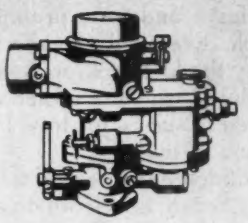


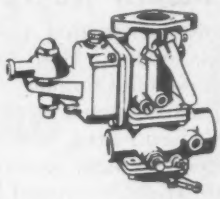
Model "B"
1 in. Regulator



Model "Cg"
Combination Carburetor

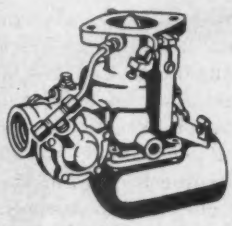
Model "F"
Regulator

Model "R" 125 H.P.
LPG Vaporizer & Regulator



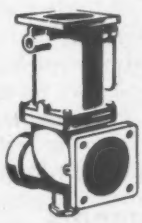
Model "Kgn1"
Combination Carburetor

Model "G1"
Gas Carburetor

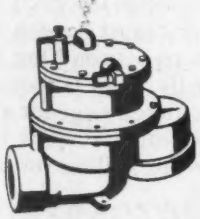


Model "Xg"
Gas Carburetor

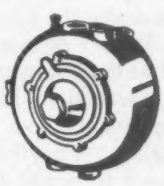
Model 2½ in. "Tg"
Combination Carburetor



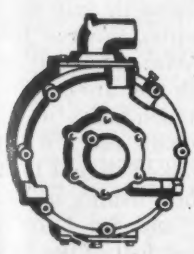
Model "A"
Gas Carburetor



Model "B"
2 in. Regulator



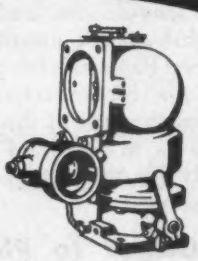
Model "W" 75 H.P.
LPG Vaporizer & Regulator



Model "S" 450 H.P.
LPG Vaporizer & Regulator

Model ¾ in. "Tg"
Combination Carburetor

Model "HD" 450 H.P.
Vaporizer



Model "Dg"
Gas Carburetor

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just short of a ton. Meantime we strained our eyes abominably looking for a patch of brown against the green, and at the first glimpse we pulled the trigger and were promptly knocked on our fan—well, we fell. Eventually staggering to our feet, still somewhat dazed by the kickback, we found that we had shot a 2600-pound Buick, and the owner appeared from nowhere and threatened to sue us for total lack of discretion and a considerable sum of money.

Ever since that time we have confined out shooting to tin ducks in a shooting gallery at Long Beach, and if we do say so, the little girl who loads the guns is pretty nice. As for fishing, we were once slapped off our balance by a four-inch trout with a careless tail, and now our favorite fishing is for the little white onion in a Gibson.

Heavy Savy

Incidentally, the aforementioned Jim Leovy is an august attorney who, besides officiating as legal counsel for Western Gulf, sits on the Los Angeles Petroleum Club board of directors and adds his deliberate acumen to the already substantial sum total. He is a competent logician who accepts nothing without examination—microscopic examination, too. His questing mind has probed every possible weakness in the entire Club adventure, and he has helped no end to keep the citadel invulnerable to assault, regardless of whence it may come.

What he does in his spare time we have not yet discovered, but in all likelihood he seeks his diversion in the perusal of a tome on Salic Law, or something equally simple—and exciting. He makes his home at Hermosa Beach, so it is possible that he also engages in some form of nautical enterprise of which we are not yet aware. However, we have our beach staff working on the case and hope to be slightly more revealing in subsequent Leovian disclosures. Meantime, we can say—and to our cost—that he sure picks up five of the most beautiful dominoes you ever saw. Also, he knows more about what wine to drink with what food than Omar Khayyam.

Swing That Peace Pipe!

An interesting ceremony took place in Oklahoma City recently when in conjunction with the Mid-Continent API meeting, the local Chamber of Commerce staged a special luncheon in honor of Magnolia Petroleum Company. This distinguished institution has played an important role in the development of Oklahoma oil from the early days of the Healdton and other fields in the Southwest of the State, to the present time. The company numbers on its staff many men who have made outstanding contributions not only to the progress of Oklahoma but to the advancement of the petroleum industry, hence also the comfort and convenience of the people, in all parts of the nation. Most of Magnolia's officers and executives were in attendance at the party and it was productive of a really enjoyable time. The feature of the program was a colorful ceremony in which J. L. "Slats" Latimer, president of Magnolia, and Judge Walace Hawkins, vice president, were adopted into the Kiowa Indian tribe by Chief Jasper Sanukeah, and were given the tribal names of *Mau-gau-om-keah*, meaning "leader of industry", and *Tau-kah-ti-keah*, meaning "the great counselor", respectively. (See Page E-6 for picture.) Prior to the ceremony, the Magnolia chief executive made an inspiring talk in which he thanked the men of the Oklahoma division for their untiring efforts in behalf of the company, and lauded them generously for their splendid record of civic interest and accomplishment.

Chief Gager to Plain Chief

Indicating the democratic spirit that actuates the Magnolia executives is their waiving of all the conventional courtesies and respects that such a distinction usually demands. We learn on very reliable authority that when the two honored gentlemen are in future spoken to in the Kiowan tongue, they do not demand, as they have a perfect right to do, that their full Indian names be given. They will on the contrary be quite happy to be simply addressed as Mau and Tau. Personally, we were much excited to discover that Slats Latimer was once a chief gager in the southwest part of Oklahoma, and that he has lifted himself by sheer natural ability and a thoroughly friendly disposition to the highest post his company has to offer. That is a bit humiliating for us. You see, we were once a chief gager, too, but there must be something wrong with our success formula, because although we have waited and waited for the phone to ring, not a soul has ever called to ask us if we would care to be president of his firm. Oh, well, we are still young!

We Mourn Henry Brett's Passing

We were distressed no end today (April 25) to hear the sad news of Henry Brett's death. Henry had been a long time with Union Oil Company of California; was for many years, indeed, superintendent of production for Union in the Los Angeles basin area, and was in every way a very lovable character. We have known him intimately for a long time, and had come to regard him highly. At frequent intervals we discussed our personal affairs with each other, and we always admired his complete lack of bias. Henry was until his death an active member of Petroleum Production Pioneers and seemed especially pleased at the opportunity offered by this organization for a meeting with his old friends both in the operating and the supply companies. He loved a bit of barber shop chording, and we have many a time sung ourself hoarse with him in the fond belief that we were dishing out harmony. Just a regular guy! That's about the best way we can describe Henry. Friendly, clean, and decent always, he was just the kind of a chap you could rely on to come up with the honest decision without any struggle, and regardless of the circumstances.

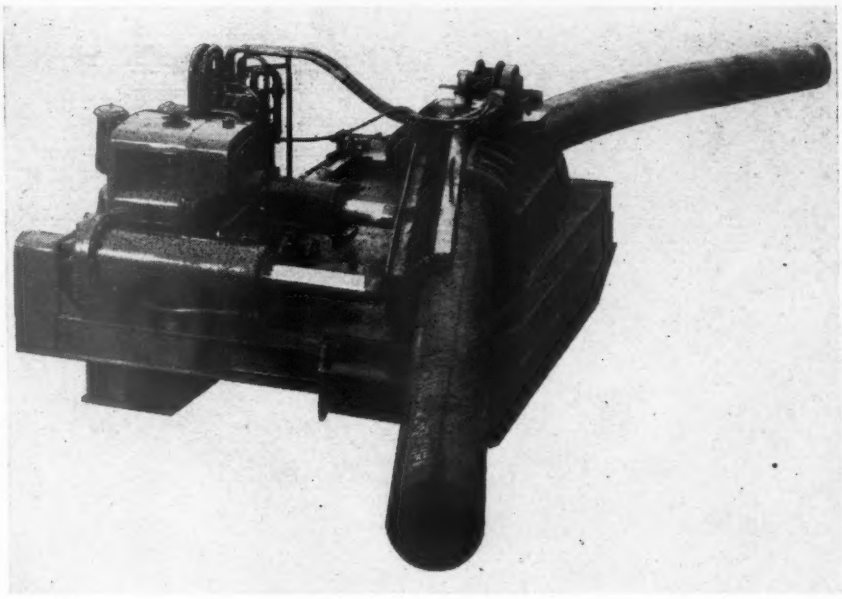
Improvements

This seems to be one of those interludes when a lot of the news is bad. Another good Union Oiler with whom we had lunch in Santa Paula just ten days ago, Clarence Froome, Union's coastal superintendent, has been ordered into the hospital for checkup and rest treatment. Here's hoping that Clarence may soon be back to his customary good health again, and doing the rounds—even if it must be with a little less vigor. We are pleased to say that reports on Clint Eddleman are that he is improving markedly. Clint is purchasing agent for Amerada, and he has had a rough siege for a while but he appears to have that old indomitable spirit that is worth a gallon of medicine, and we are pulling for him in his fight back to health and strength.

On a Gossamer Line, Too

Jock Macco, the Scottish producer, looked as if he were going to walk off with the Nineteeners Calcutta at Rancho Santa Fe. He had a 66 net the first day, but something went wrong on the second day, and Bill Cline, the dapper chairman of California chapter AAODC came in with the championship score. Ed Stearns, Jim Gosline, Warren Johnson, and Tom Selser, are going down to Mazatlan early in May to go after some of the 600-pound fish that are caught down that way. Last year they didn't have much luck—just caught a few sprats weighing about 400 pounds each. When they left the hotel, three other oil men walked in and took over their rooms, their *aqua fortis*, and their fishing tackle. This trio, Ed Pellegrin, Dutch Schmeider, and Bob Gentry, then proceeded to catch some of the biggest fish of the season—one of them, we are told, weighing a trifling 660 pounds. Wherewith we leave you to your own devices. Remember, many a true heart beats beneath a ragged pair of trousers.

COODY BENDER AMAZES INDUSTRY AGAIN



PAT. PEND.

MAKES SMOOTH BENDS ON 6" TO 16" PIPE

Houston, Texas, March, 1950. The Coody Bender Company, Inc., whose "Cinch Bender" has been recognized throughout the pipeline and related industries for providing a speedy, economical and safe means of pipe bending, has hit the market with another amazing pipe-bending machine. The first "Cinch Bender" is designed to handle pipes from 16" to 30" O.D.; the new machine is designed to handle pipes from 6" to 16" O.D. This latest product of the Coody Bender Company can be utilized by compressor stations, intercity transmission lines, refineries, chemical plants and any other operation that requires the bending of steel pipes. Identical with the larger "Cinch Bender" the new machine works right on the job. It makes smooth full-formed bends without effecting wall thickness of pipe.

CONTRACTORS PRAISE CINCH BENDER

The superior and speedy "Cinch Bender" machines have been used on just about every pipeline in the United States, having won only the highest praise. Here are a few of the actual statements made by some of America's outstanding pipeline contractors concerning this completely satisfactory production aid: " . . . As you probably know the H. C. Price Company was contractor on approximately three-fourths of the Columbia Gas System project in West Virginia. It was very common for our crews to make between sixty-five and eighty-five bends per day with the Coody Bender, and there were a number of instances in which an excess of one hundred bends were made in a single day's operations . . . " (Signed: David J. Kerr, Public Relations Director, H. C. Price Company, Bartlesville, Okla.)

" . . . with one Coody Bending machine we have made as many as seventy bends with average of 7° to 9° with the range of bends varying from 2° to 38½° in a 60 foot joint of pipe." (Signed: C. C. Bledsoe, Secretary-Treasurer, Midwestern Constructors, Tulsa, Okla.)

" . . . On the section of the Texas Gas Transmission Corporation 26 inch job located West of the Ouchita River, which was through rather choppy terrain, using the Coody Cinch Bender, we made as many as ninety bends of A. O. Smith 26 inch O.D. 9/32 inch wall thickness line pipe." (Signed: R. P. Gregory, Vice President, Latex Construction Company, Houston, Texas.

BENDS UP TO 90° ON 20 FT. OF 12" PIPE

The new Coody "Cinch Bender," pictured above, will complete bends up to 90° on 20 feet of 12" pipe without effecting wall thickness of the pipe. In fact, this boon to the pipe-bending business keeps the wall thickness and the roundness of the pipe within the specifications for new straight pipe. Engineering and laboratory tests prove that bends made by the "Cinch Bender" have improved yield and tensile strength. This streamlined, modern machine does away with costly kinking of pipes, as well as continual starting and stopping of the machine. Thus, cleaning and priming, doping and wrapping all become a continuous operation.

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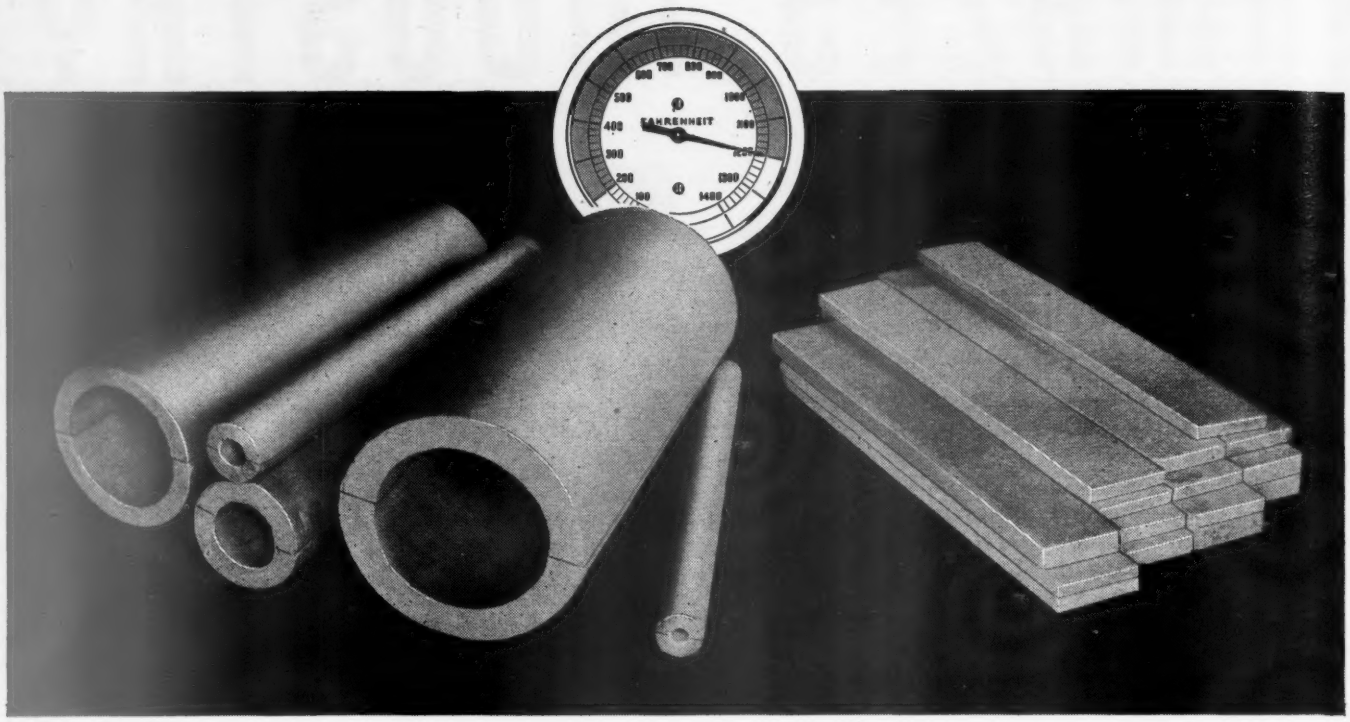
ONE MATERIAL INSULATES A 200°F.-1200°F. TEMPERATURE RANGE



KAYLO HEAT INSULATING BLOCK can be easily sawed, cut and scored with standard tools. Cement, canvas or other outer finishes can be applied with minimum effort. Finished jobs have a neat, clean appearance.

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MEETINGS

May 15-18—API Midyear Meeting on Safety, Central Committee on Accident Prevention and Fire Protection, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

May 25-26—Natural Gas and Petroleum Assn. of Canada, Annual Convention, Prince Edward Hotel, Windsor, Ont., Canada.

May 28-31—The American Institute of Chemical Engineers Regional Meeting, Swampscott, Massachusetts.

May 29-31—Fifth Annual Short Course in Gas Technology, Texas A & I, Kingsville, Texas.

June 4-9—SAE, Summer Meeting, French Lick Springs Hotel, French Lick, Indiana.

June 8-10—National Oil Scouts and Landmen's Assn., Oklahoma City, Okla.

June 12-16—ASME, Oil and Gas, Power Division, Lord Baltimore Hotel, Baltimore, Md.

June 12-16—American Institute of Electrical Engineers Summer and Pacific General Meeting, Huntington Hotel, Pasadena, California.

June 15-16 — Pennsylvania Grade Crude Oil Assn, Annual Meeting, Hotel William Penn, Pittsburgh, Penn.

June 18-20—Petroleum Equipment Suppliers Assn. The Greenbrier, White Sulphur Springs, W. Va.

June 19-23—ASME, Hotel Statler, St. Louis, Mo.

June 20-24—Canadian Gas Assn. Annual Meeting, Manoir Richelieu, Murray Bay, Quebec, Canada.

June 26-30—API, Production Division, Mid-Year Standardization Conference, Brown Palace Hotel, Denver, Colorado.

June 26-30—American Society for Testing Materials Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

August 3-5—Interstate Oil Compact Commission, French Lick Springs Hotel, French Lick, Indiana.

Aug. 14-16—SAE, West Coast Meeting, Biltmore Hotel, Los Angeles, Calif.

Aug. 30-Sept. 1—Tenth Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, West Virginia.

Sept. 3-8—American Chemical Society, Chicago, Illinois.

Sept. 5-9—National Chemical Exposition, Chicago Section, American Chemical Soc., Coliseum, Chicago, Ill.

Sept. 10-13—The American Institute of Chemical Engineers Regional Meeting, Minneapolis, Minnesota.

Sept. 11-13—Oil Industry Information Committee, Hotel Traymore, Atlantic City, N. J.

Sept. 11-15—ASME Industrial Instruments and Regulators Conference with the Instrument Society of America, Municipal Auditorium, Buffalo, New York.

Sept. 13-15—National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.

Sept. 14-15—Midwest Gas Assn., Gas School and Conference, Ames, Iowa.

Sept. 18-22—Instrument Conference and Exhibit, Instrument Society of America, Memorial Auditorium, Buffalo, New York.

Sept. 25-27—ASME, Petroleum Mechanical Engineering Division, The Roosevelt Hotel, New Orleans, Louisiana.

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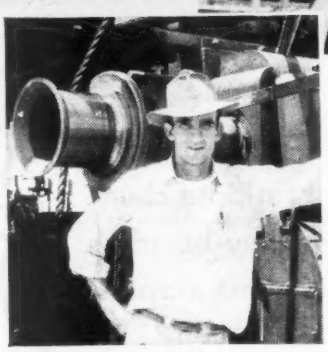
says James G. Cullum of Wichita Falls, Texas



Wilson Giant rig, operated by Cullum Brothers Drilling Co., is powered by two GM Series 71 Diesel Twin sixes delivering 276 continuous H.P. per twin at 1000 RPM shaft speed. Table speed up to 180 RPM. Gardner-Denver 7¾ x 16 mud pump, V-belt driven from chain compound, delivers 650 to 700 lbs. pressure with 7¼" liners, 63 strokes per minute.

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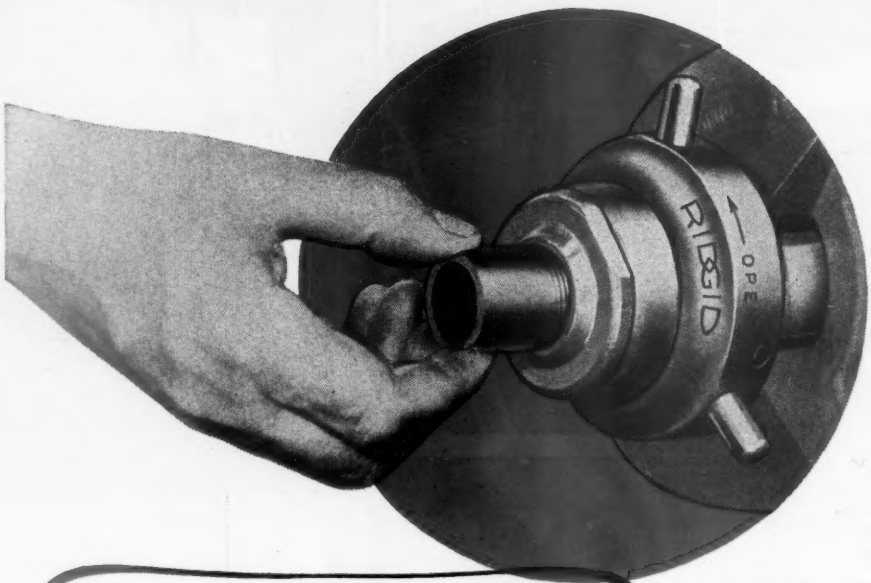

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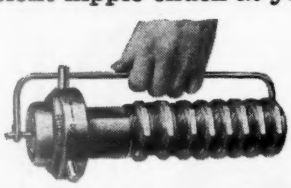

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A-20

Oct. 1-3—IPAA, Annual Meeting, Jefferson Hotel, St. Louis, Mo.

Oct. 2-6—AGA, Annual Convention, Atlantic City, New Jersey.

Oct. 2-6—Mid-Continent Oil and Gas Assn, Louisiana-Arkansas division, The Roosevelt Hotel (tentative), New Orleans, La.

Oct. 4-6—AIME, Petroleum Branch, Fall Mid-Continent Meeting, Roosevelt Hotel, New Orleans, La.

Oct. 4-5—Mid-Continent Oil and Gas Assn, Texas Division, Baker Hotel (tentative), Dallas, Texas.

Oct. 9-10—American Assn of Oilwell Drilling Contractors, Annual Meeting, The Mayo, Tulsa, Okla.

Oct. 12-13—AIME, Petroleum Branch, Fall West Coast Meeting, Elks Club, Los Angeles, Calif.

Oct. 15-21—Oil Progress Week.

Oct. 23-27—AIEE, Fall General Meeting, Skirvin Hotel and Skirvin Tower Hotel, Oklahoma City, Okla.

Oct. 30-Nov. 1—National Lubricating Grease Institute, Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

Nov. 9-10—SAE, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

Nov. 10—California Natural Gasoline Assn, Annual Meeting, Ambassador Hotel, Los Angeles, Calif.

Nov. 11-13—Oil Industry Information Committee, Biltmore Hotel, Los Angeles, Calif.

Nov. 13-16—API, Annual Meeting, Biltmore Hotel and Ambassador Hotel, Los Angeles, Calif.

Dec. 3-6—AIChE, Annual Meeting, Columbus, Ohio.

1951

Apr. 18-20—National Petroleum Assn, Hotel Cleveland, Cleveland, Ohio.

May 28-June 6—World Petroleum Congress, The Netherlands, The Hague.

June 16-20—Canadian Gas Assn, Bigwin Inn, Lake of Bays, Ontario, Canada.

Oct. 14-20—Oil Progress Week.

Nov. 5-8—API, Annual Meeting, Stevens-Palmer House, Chicago, Ill.

NOMADS TO MEET

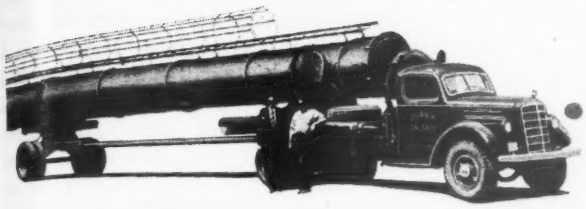
New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York, N. Y. Sec. Russ V. McIntire, 11 West 42nd Street, New York 18, New York.

Houston Chapter, Second Monday of the Month, Ye Ole College Inn, Houston, Texas. Sec. Harry E. Estes, P. O. Box 9321, Houston 11, Texas.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Sec. John W. Rife, 5905 Pacific Blvd., Huntington Park, Calif.

Tulsa Chapter, Third Wednesday of the Month, Hotel Tulsa, Tulsa, Okla. Sec. G. W. Davidson, Jr., Box 1188, Tulsa, Okla.

Dallas Chapter, Dallas, Texas, First Monday of the month. Sec. C. J. Berlin, P. O. Box 2968, Dallas, Texas.



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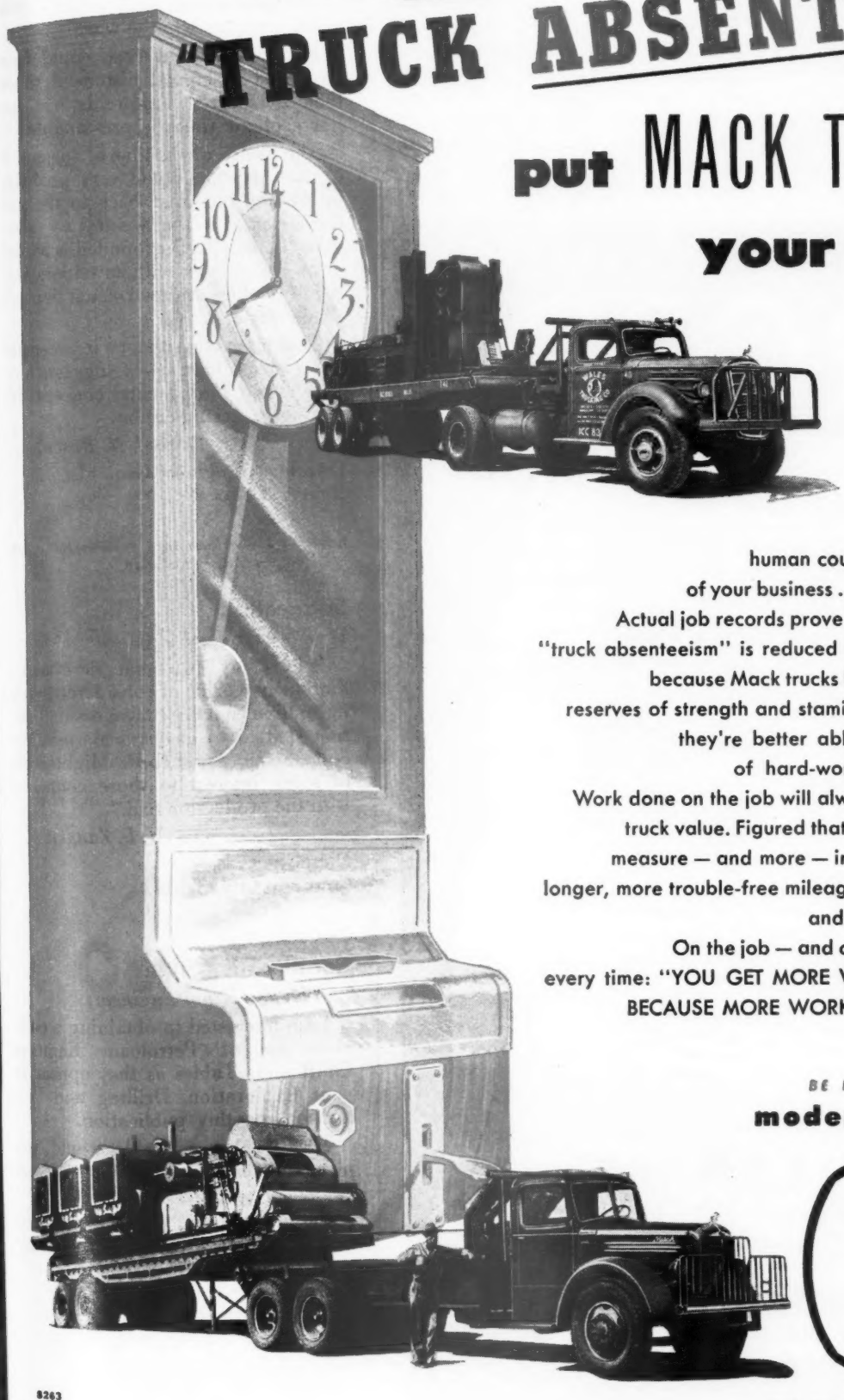

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LETTERS
to the Editors

Origin of Oil

To The Petroleum Engineer:

"Worlds in Collision," by Dr. Immanuel Velikovsky is a stimulating bit of reading for any geologist. It has been briefly reviewed in Readers' Digest, March 1950, and in Colliers, February 28, 1950, to which the reader is referred.

For a petroleum geologist, familiar with the Lake Maracaibo, Brazilian, Eastern Andean, Alberta tar sand, and Teritary oil deposits, it suggests a possible new source of some of these petroleum deposits.

In the "Manuscript Quiche," of the Mayas (and hence on a large portion of the Central America and surrounding areas) and in the "Bamboo Books of China" (and in corresponding areas), a rain of pitch is mentioned. This could quite logically (to a petroleum engineer well grounded in refinery practice and in hydrogenation and polymerization) occur from the combination of hydrogen and carbon, probably in the upper atmosphere. Then, when lakes and seas were coated with pitch, tidal waves hundreds of feet high (further documented) could have swept these accumulations against the shores, and buried them beneath some hundreds of feet of sand, or other marine debris. Thus we might have certain oil deposits *in Situ* in various places in the world.

If such an occurrence could have happened in known historical times, then its recurrence in prehistoric, earlier geologic times is presumable.

The theory of the time of formation of such deposits could very probably be worked out clear back to the pre-Cambrian, by the writer, by some other equally well grounded scientist, or an astronomer with an understanding of geology and petroleum deposits of the world.

This interesting theory is presented for reader comment—it suggests a review of our fundamental concepts for petroleum accumulation.

Frank N. Bosco,
Petroleum Engineer-Geologist
Denver, Colorado.

Editor's Note: *See Book Reviews for a comment on "Worlds in Collision."*

Suggestion

To The Petroleum Engineer:

I have my own shop here and I find the magazine of considerable help in my line. Why not have a small section slanted to mechanical casualties and ways to avoid them. Might prove of some interest to those connected with the production end.

H. L. Zanger.
Diesel Service,
Colorado City, Texas.

Continuous Tables

To The Petroleum Engineer:

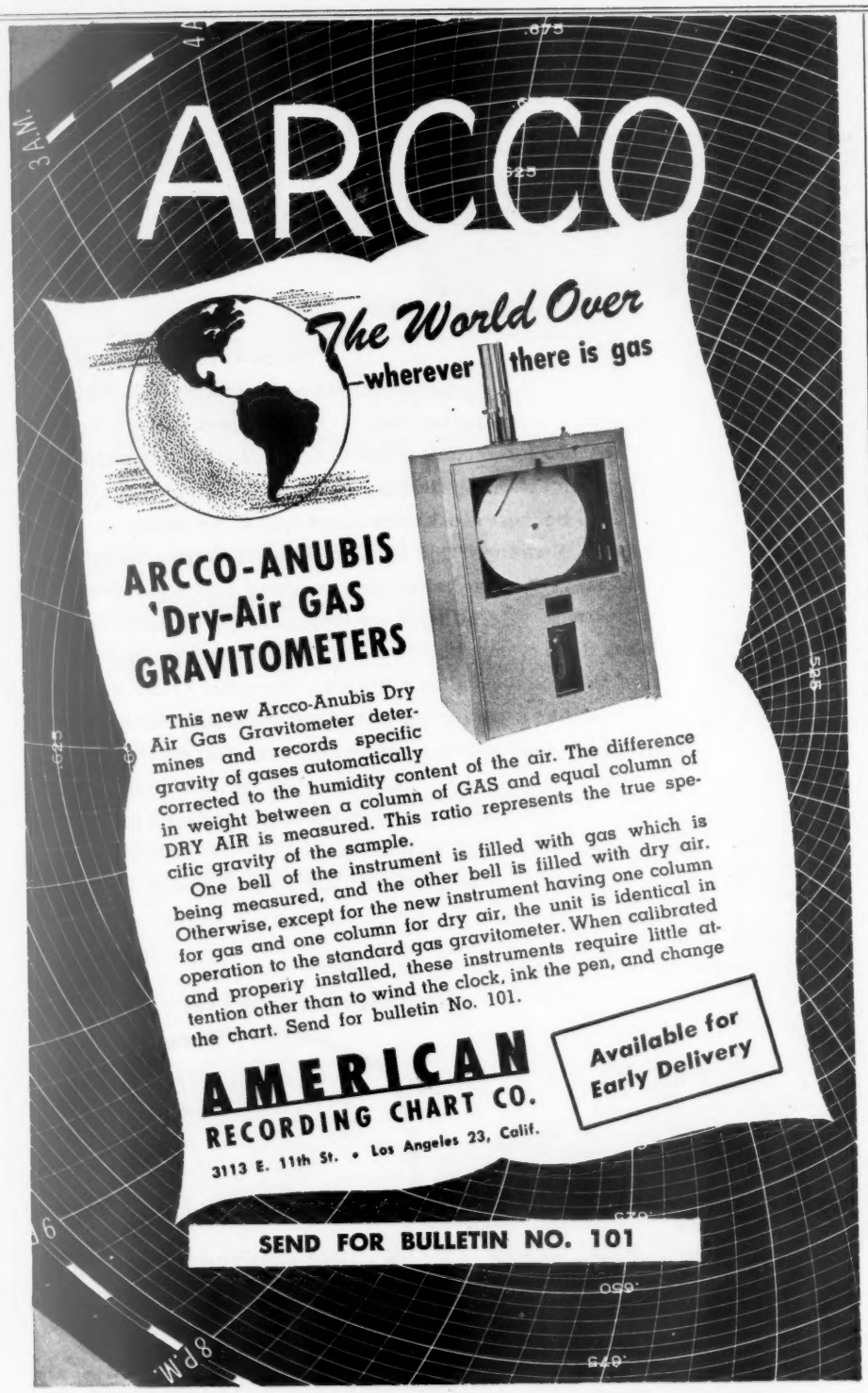
I am interested in obtaining a complete set of Petroleum Engineer Continuous Tables as they appear in your Exploration, Drilling and Production monthly publication.

If these are available would you please give me a quotation on the cost of the complete set.

I find your publication very interesting and of considerable assistance in my work.

Elmer M. Berlie,
Production Engineer
Edmunds, Coons and Akehurst,
Lloydminster, Saskatchewan
Canada.

Editor's Note: *The Continuous Tables are out of print in book form but republication is scheduled in the future.*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GRAVITOMETERS
This new Arcco-Anubis Dry Air Gas Gravitometer determines and records specific gravity of gases automatically corrected to the humidity content of the air. The difference in weight between a column of GAS and equal column of DRY AIR is measured. This ratio represents the true specific gravity of the sample.
One bell of the instrument is filled with gas which is being measured, and the other bell is filled with dry air. Otherwise, except for the new instrument having one column for gas and one column for dry air, the unit is identical in operation to the standard gas gravitometer. When calibrated and properly installed, these instruments require little attention other than to wind the clock, ink the pen, and change the chart. Send for bulletin No. 101.
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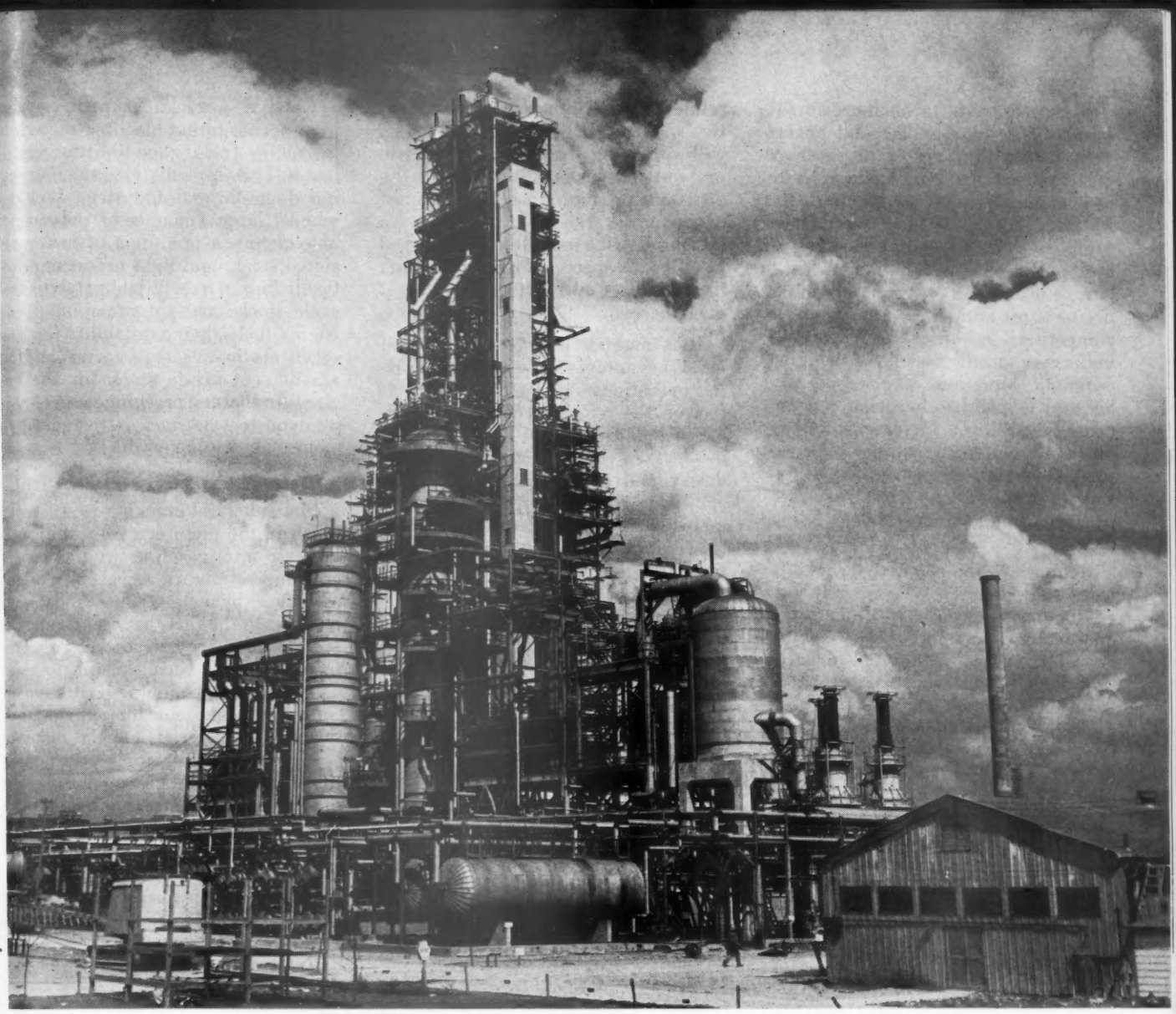


Sun Oil Company's Toledo (Ohio) refinery has a modern quadruple-reactor Houdriflow unit reaching 308 ft high. Is said to be only catalytic cracking unit of its type.

P 701.

Octane Race a Reality in 1950

ARCH L. FOSTER*

Saturation of Motor Fuel Markets Places Emphasis on Selling Properties of Gasolines. Lubricating Oil Capacity Is Found to Be Saturated.

EXCLUSIVE

POSTWAR recovery of peacetime refining capacities and the flattening of the demand curve for motor fuels, lubricants, and other petroleum products have made a buyers' market in gasoline especially. Postwar engines are climbing slowly but surely upward in octane demands, as octane requirements and compression ratios mount hand-in-hand on a mild slope. Bureau of Mines and other motor fuel surveys, such as duPont's quarterly look-see at octane ratings, etc., show that average compression ratios are climbing a fraction of a unit each year. Special engine "jobs," which call for superfuels in the range of 92-95 Research Octane number are more common as the wartime extra earnings are spent by those citizens not yet reduced to "normal" earning power.

As a result of all these inevitable forces, the "octane race" is on with a bang. As has always been the case

*Refining and Gas Processing Editor.

this race appears to be more in the minds of gasoline sellers and buyers than in the thinking of the average customer on the street. Faced with a potential surplus of gasoline, the industry rushes to add more sales arguments to its selling repertoire, and pushes the installation of catalytic crackers and polymerizers in order to boost anti-knock ratings above competitors in order to dispose of high cost production in a sagging economic situation. The sag is not because demand is lowering but because the rate of increase is falling off, a development as inevitable as time, following the saturation of refining capacity, which now approaches but has not reached fulfillment.

Refiners without catalytic equipment find themselves hopelessly out of the running in competing on a quality basis for the business of buyers who now can obtain good gasoline from several sources instead of only one, or none at all as has been the case some of the time in the past few years. As a result a scramble has developed for markets, to the detriment of the price structure. R. W. "Bob" McDowell, president of Western Petroleum Refiners Association and executive vice-president of Mid-Continent Petroleum Corporation, told his cohorts recently in substance that market price distress is traceable probably to not more than five per cent of the total amount of motor fuel available; he urged in effect that refiners use more discretion and avoid stampedes under such conditions.

Those refiners who have provided their manufacturing divisions with adequate catalytic and other up-to-date postwar refining facilities in many instances are finding themselves in the enviable position of leading the parade, not only in the quantity and quality of motor fuel that they can supply to their own distribution branches but in supplying high octane blending material or high octane rating finished motor fuels to other refiners not so "fortunate." Use of the word "fortunate" may be considered of doubtful judgment, since the large problem of paying for these catalytic units may yet include a sizeable headache to even the most efficient refiner. On the other hand, many economists contend that catalytic cracking especially is a decidedly advantageous operation, from any economic angle, reasons for which are given later. To illustrate the position of the refiner with a new cat cracker in an area where others do not yet have such facilities, common discussion credits one southwestern refiner, although operating on a relatively corrosive, high sulfur crude, with supplying from his new catalytic unit not only his own stations with 90-93 octane premium fuel, but also most of the marketers in his area with either blending naphthas or finished gasoline to meet competition—from the supplier's own stations in a great many cases.

It is nothing new to observe that other advantages for catalytic cracking operations are potent in their effect on the refiner's economy. Residual fuel oil is dying the death hastened by progress in the technology of industry and commerce. Two decades ago heavy residual fuels were the mainstay of every railroad west of the Mississippi. Practically every locomotive built during the 1920-35 period was designed for heavy fuel oil, much of which came from the residues of thermal cracking; a boon to the refiner who thus could dispose of these otherwise unsalable end-products at minimum loss, to help carry the load placed on his motor fuel production. Catalytic cracking was then a thing for long haired experimenters to play with, neither understood, believed in nor trusted by hardheaded refiners. Diesel-electric locomotives, likewise, were in their troublesome infancy, not yet proved as first-line prime movers.

That situation has changed diametrically; none can say how much the advent of catalytic cracking is the result of and how much the cause of, the tremendous increase in the use of heavy oil-burning engines, of distillate heating oils, and of other applications of middle-of-the-barrel products. Diesel electric locomotives have stolen the entire railroad power show; a very small percentage of the oil-burning locomotives on order on January 1, 1950 were for heavy oils; only a small list of locomotives were building for coal; the diesel electric has the stage, overwhelmingly.

Catalytic cracking makes a minimum of heavy uncrackable residue. Most of its heavier-than-gasoline product is in the range of distillate heating oils, or is recycle stock for thermal crackers, which can handle and crack refractory stocks better than catalytic operations can, although still making some heavy residual oil. Catalytic cracking also can make widely varying amounts of light olefins as stock for the catalytic polymerizer, at the will of the operator. Both cracked and polymerized products boost the octane rating of the finished gasoline made, although lead susceptibility of these highly naphthenic, aromatic, olefinic fractions is low.

Catalytic cracking, then, yields high octane rating blending materials for motor fuels, good-to-better distillate fuel oils for satisfying the increasing domestic and industrial fuel demands, large amounts of polymerizable olefins, a minimum of heavy residual stock, and light products practically sulfur-free. While catalytic recycle stocks are not premium diesel engine fuels, their availability for fuel oil effects the release of corresponding amounts of virgin stock for the engines. In thermal cracking most of this catalytic recycle stock is recracked to motor fuel and heavy fuels.

Thermal Cracking Still Practical

Since thermal cracking is still very much in the picture due to ability to increase total gasoline production by cracking refractory recycle stocks not crackable by catalytic methods, and also due to the fact that many refiners still do not have cat crackers, the refiner must look for means of disposal of heavy fuel residues. Railroads of course still take considerable quantities of this material, but the demand is lessening rapidly for reasons mentioned above. The greater number of the 25 or more thermal crackers built or revamped during the last 18 months are either new cokers—delayed coking—or are old thermal units converted to coking operations by addition of coke chambers, etc. Running to coke the refiner eliminates heavy fluid residues, increases total gasoline and light olefin production, cracks the recycle stocks from his cat cracker, and has only relatively small amounts of solid coke to dispose of, generally as local domestic fuel or for industrial purposes, instead of large quantities of drug-on-the-market Bunker C and heavier fuels.

For these and other reasons too numerous to mention, the installation of catalytic crackers is continuing, and is finding locations in relatively small units. To this witness the Tide Water and Shamrock Houdriflow units in the 4000-5000 bbl per day caliber; the recently completed and on-stream Cosden Fluid unit of the same size, and more recently the Panhandle midget FCC plant of 1300-1500 bbl per day fresh charge. Technically these units now on stream are showing good results in quantity and quality of products. The economic picture is fainter in the painting, and must wait on more settled conditions before determination of the cost-return ratio.

Simplification of design is reducing installation and operating costs appreciably for these units. Elimination of the bulky and expensive electrical catalyst precipitators is one decided

advance. Design of reactor and regenerator in one tower for Fluid units improves the economic picture. Elimination of the bulky and troublesome mechanical catalyst lift system for Thermofor units, and the introduction of other Houdriflow innovations have improved the refiner's outlook greatly.

Both Fluid and Houdriflow processes claim yields of 40 to 60 per cent motor fuel based on charge, plus 20 to 45 per cent catalytic gas oil which may be cracked thermally or sold as distillate fuel; plus 15-20 per cent of butanes, butenes and propylene, the last two for the catalytic polymerizer unit.

In this discussion of product advantages, we must not overlook the fact that the heavy end of catalytically cracked gasoline is essentially as high in octane rating as is the light material, in strong contrast to thermally cracked gasoline, the heavy portion of which is relatively low in anti-knock. Consequently it is economic to make 425 F endpoint motor fuels, where with thermal operations only the endpoint must be held to 390-400 F or lower to avoid depressed octane ratings and excessive TEL consumption.

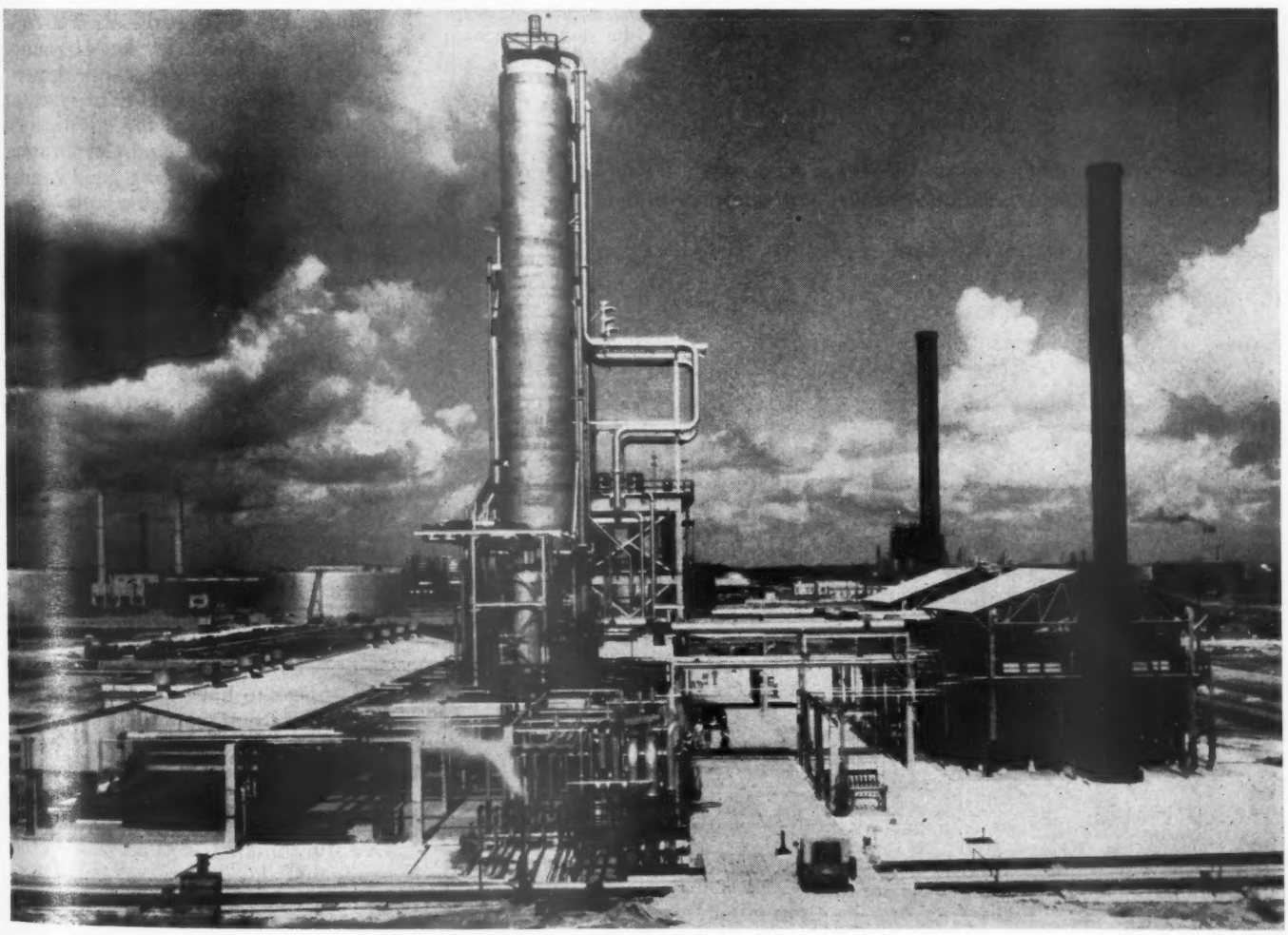
Other innovations include the use of essentially undiluted air in the catalyst regenerator, a step that simplifies and lowers the cost of regeneration equipment required. Utilization of the residual heat in regenerated catalyst to vaporize the charge stock, as in the Fluid units, eliminates separate preheater furnaces, again reducing the installation and operating costs. Waste heat boilers have been used in cat crackers all along. Some of the smaller units have been installed without spare or standby slide valves and other precautionary equipment, the absence of which may or may not prove to be a bottleneck in unit operations.

Desulfurization capabilities of cat cracking units makes it feasible to operate on relatively high sulfur crudes with the production of essentially sulfur-free motor fuels and other products. This same situation makes for expense in providing satisfactory, corrosion-resistant metals in these units; piping and other equipment often are made of stainless or 18-8 steels, with 4-6 chrome as another widely used alloy for these critical applications. Stainless and other alloy steel linings are employed where practicable, using plain carbon steel for base metal.

Catalytic Reforming

As in the case of thermal cracking and reforming, catalytic reforming applications are following rather than leading the cracking of heavier oils by catalysts. To date two main processes hold the limelight for cat reforming. The older method has several units installed especially in the west and southwest, the Cycloversion process, employing a bauxite or other aluminum oxide type of catalyst which profits from relatively low cost, long on-stream periods and long catalyst life. Shamrock Oil and Gas Company, for example, has been operating a Cycloversion unit, mainly as a heavy oil cracker, and is now installing a Houdriflow cat cracker to round out the company's refining facilities. It appears that such a combination as a

At Lake Charles, Louisiana, Cit-Con's "twin" vacuum distillation units shown here can each handle 12,500 barrels a day of reduced crude. Design provides overcapacity to permit producing a higher proportion of neutral oils to bright stock when required.

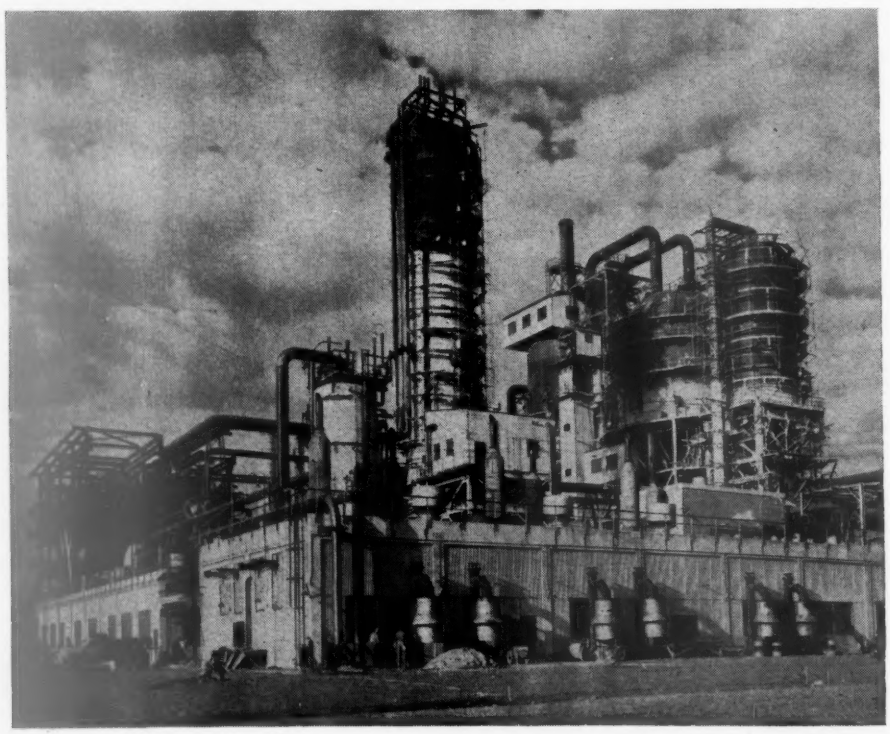


heavier-than-gasoline catalytic cracking units with a smaller capacity cat reformer, which reduces sulfur seriously may be the Five-Aces in the refiner's deck to meet the buyer's market conditions now developing strongly.

Catalytic polymerization, long a standby of the refiner to boost both yields and octane ratings appears to have not a death blow but a new lease on life with the widespread installation of catalytic cracking. Production of olefin C_3s and C_4s may be changed widely by catalytic cracking operating conditions and gas concentration units supply generally a charge stock to the polymerizer containing olefins to the order of 50 per cent of the total. Non-selective polymerization increases total gasoline yield to an even greater degree than was or is the case with thermal cracking units. Combining this advantage with that of the higher endpoint for catalytic motor fuels (made possible by reason of the higher octane ratings of the heavy ends of cat-cracked fuels) improves vastly the refiner's position by yielding a greater volume percentage of products, which sell at prices higher than the original crude cost, a "must" situation under present conditions. Both types of catalyst are employed with the greater number using the UOP phosphoric acid catalyst. At least one poly unit being revamped to handle the added charge load from a new catalytic cracker, however, is changing from this to the Kellogg pyrophosphate type catalyst.

To the technologist the most intriguing development in reforming or in catalytic circles for that matter is that of the new UOP Platforming process. A comprehensive article discussing this process was presented in these pages in the April, 1950 issue. Use of metallic platinum as catalyst results in sulfur reduction and in the important raising of octane ratings on naphthas. For example, the Old Dutch Refining Company of Muskegon, Michigan, operating on 49-50 octane rating Michigan naphtha of a boiling range of 200-335 F raised the rating to 86 Research clear rating; sulfur is dropped from 0.045 per cent to a few thousandths (0.002). A wider boiling charge has its octane rating raised from 49 to 81, and also lowers the initial boiling point from 176 to 86 F. This Old Dutch unit has been operating for several months and while the economics of the process is not determined for the average refiner, data at the present indicate that the process has a very definite place in the picture. The one potential drawback to the process as seen by the bystander refiner is that of the high initial catalyst investment. The catalyst is not regenerated at present, at least not in the unit, as is the case with cracking catalysts of baser metal oxides; it appears to be resistant to sulfur and other catalyst poisons and its active life is unknown so far. Four months' operation shows no appreciable deterioration in catalyst activity; the licensors of the process state only that "We expect the catalyst to remain in service for a long time."

Giant catalytic cracking unit at The Texas Company's Eagle Point Works. It processes a million gallons a minute and operates around the clock.



Thermal Cracking

The ancient and honorable routine of thermal cracking appears also to have a new lease on life, mainly in the delayed coking type of operation. Several delayed coking units have been built recently, while older units have been converted to coking by addition of coke chambers and other required auxiliaries. Thermal cracking will return the refiner more motor fuel on his investment in many cases by cracking refractory catalytic cycle stocks, which cannot be handled in the cat cracker as satisfactorily. Since heavy fuel oil is in lessening demand, the refiner cannot use more heavy cracked residual oil, therefore coking is the most successful method of disposing of these undesirable products, to yield a minimum of off-premium fuel, solid coke. Refiner leaders see in this trend a long life for thermal coking unit processes, as aid to solution of this painful heavy residual oil dilemma.

Advances in catalysts are continuing apace, too numerous to mention. Typical of the best of these researches is the work reported by Dr. Hermann E. Ries, of Sinclair's research department, on the occasion of his receipt of the Ipatieff Award for meritorious work in catalysts. Filtrol Corporation is reported to be showing good results from the use of its new, processed natural cracking catalyst. One or more refiners are reported to have changed from synthetic catalyst to this new product with advantageous results.

Synthetic Products

Foremost, in the news at least, in the synthetics field is that of synthetic hydrocarbon products from oil shale, natural gas and coal. The intensive and extensive efforts of the Federal Government to develop processes for "augmenting our dwindling petroleum reserves," (to quote one misleading statement), has resulted in important reduction in the cost of mining oil shale, according to reports that appear to have good foundation. Oil leaders point out, however, that in all or most of the cost figures quoted by Federal agencies important items have been omitted, and base values are erroneous, often merely "wishful thinking" estimates, with the result that the general public is misled as to the state of our petroleum

reserves, the necessity for synthetic methods in the foreseeable future, and the costs and yields of products obtainable by these processes. When the report of the Secretary of the Interior stated that gasoline may be made from oil shale for 9 cents per gallon, Solliday of Stanolind Oil and Gas Company emphasized that the industry estimates this cost actually at 22.5 cents per gallon. Solliday states the Federal estimates fail to include such items as those below:

1. Cost of housing workers at remote mining areas and mine to market transportation costs for products not considered.

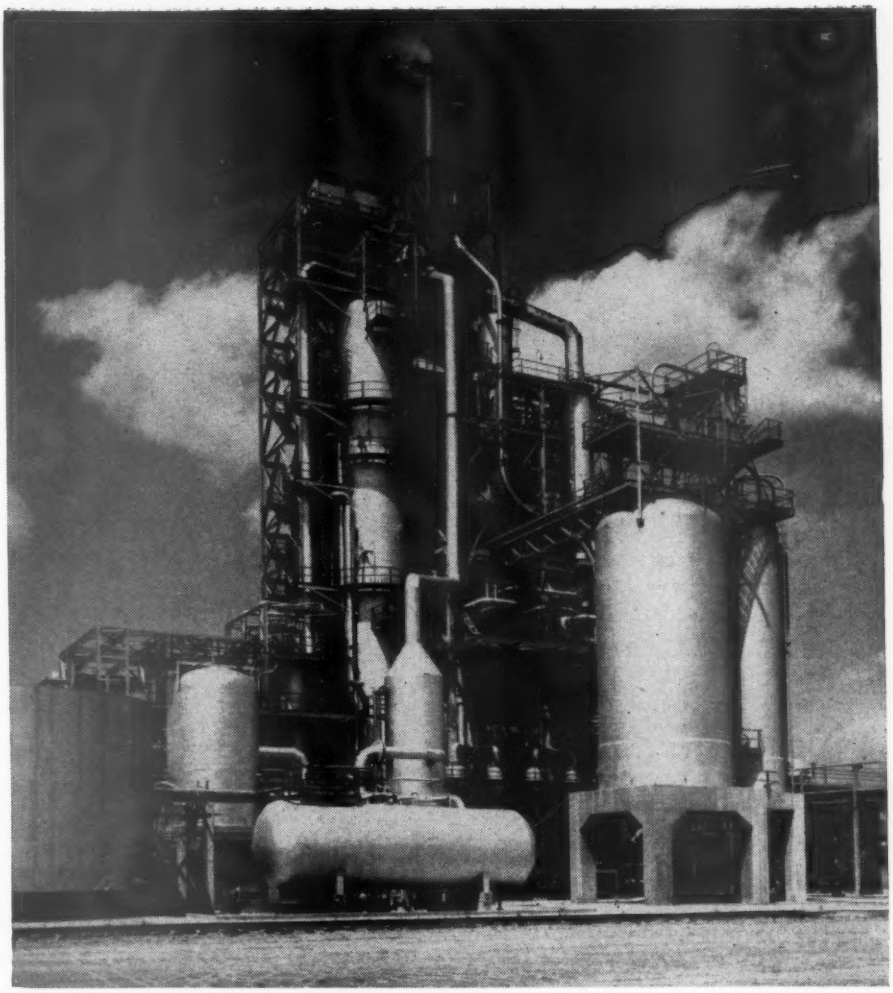
2. Calculation of costs on low-premium products such as diesel, residual, and jet fuels, which at present have little market value or demand.

3. Return on investment of 3 per cent is too low, especially in the face of the great risk in these operations.

4. Calculations of capital investment in these processes is placed at unrealistically low levels.

The Interior Secretary also claimed 14.5 cents per gallon as total cost for making gasoline from coal by hydrogenation, as against the industry's estimate of 22.5 cents per gallon for either coal hydrogenation or oil shale. One instance of the unrealistic method of publicizing costs is that in which it is stated, "The direct mining cost (for oil shale) excluding depreciation, general office expense, and overhead, was 29 cents per ton of shale." Publication of such figures to the general, non-technical public, blithely overlooking the items, which cannot be omitted from practical estimates without potential disaster and without conveying totally erroneous impressions, is considered dangerous policy by the oil industry and other business and industrial leaders. It is an indubitable fact that much technical progress is being made, however, by Federal and industrial bodies working purposefully at these various problems, on which the petroleum industry believes research work should be pushed, without going into large scale commercial activities at present.

Outstanding progress is being made in synthetics of different types by the industry. A new lubricant from abundant raw materials, having 140 viscosity index and minus 10 F pour point is announced by Socony-Vacuum Oil Company Researcher F. M. Seger and collaborators. This product is made from coal, oil shale, and refinery byproducts. It appears to possess qualities in excess of those made from conventional petroleum bases. Synthetic lubricants with anti-wear properties "18 times better than petroleum oil," have been announced by research men of Union Carbide and Carbon Corporation. These oils are known as "polyalkylene glycol" products. Improvements in butyl rubber tubes to prevent their buckling at very low temperatures with resultant splitting in service have revived the butyl industry and enable these rubbers to be used to advantage. For a time it appeared that natural rubber might recapture its large lost inner-tube markets, say Standard Oil Development Company's Esso laboratories investigators.



Ohio Oil Company's Robinson, Illinois, Fluid catalytic cracking unit designed by Universal Oil Products. Throughput is 12,400 bbl a day.

Among other relatively new products that may be mentioned are the polyethylene film materials, which are used to wrap vegetables and similar materials. These allow oxygen and carbon dioxide more nearly free passage and hold water vapor to a much greater degree. Jet engine fuels can be made by hydrogenation processes from shale oil, say Drs. Lankford and Ellis of the U. S. Bureau of Mines, in emphasizing new sources for such fuels as jet, diesel, and heating fuels. This development is nothing new to the industry. The absence of cost figures, which are "not available" lessens interest in these developments for immediate uses.

Elimination of various metals and elements that are antagonistic to anti-knock agents, such as tetraethyllead, is necessary for the best fuel properties, says Dr. H. K. Livingston of du-Pont's laboratories. The new autothermic light hydrocarbon cracking process can be used to produce large quantities of fuel gas to meet peak loads, says Dr. R. M. Deanesly of Universal Oil Products Company. Such light hydrocarbons may be stored underground or otherwise, to be cracked to make greatly increased volumes of fuel gas when required, it is claimed.

These are a few of more important processes that are being used by the refining industry to meet the requirements of its customers in this postwar expansion trend, which appears to be gaining rather than losing momentum.

* * *

The Tito Regime Pushes Petroleum Development But Now Depends Upon Already Refined Imports for Supply

OIL IN YUGOSLAVIA

UNDER the five years plan of the Tito regime the problems of exploration and production of oil are vigorously attacked. Large expenditures are made to buy new geophysical equipment and particularly drilling rigs. A certain amount of trained personnel existed before the war; additional ones have come from Hungary and Rumania. Training of the local personnel is progressing rapidly. There are already several small fields and as exploration has barely scratched the surface, there are good possibilities.

The present picture is as follows:

Production. Total production is around 300 tons a day (about 2000 bbl). It is divided in three regions (see map).

1. **Croatia.** It is in Western Yugoslavia, bordering Hungary. Three fields are centered around its capital, Zagreb.

a. Lendova 100 miles north of Zagreb is the prolongation of the Hungarian field of Lovdszi into Yugoslavia. It produces around 1700 meters (5600 ft) from Miocene sandstones. Twenty-five to 30 wells are on production, most of them flowing. The field production is around 130 tons per day (900 bbl). The best producer does not exceed 150 bbl per day.

The field limits are not very well known yet and in addition there are interesting possibilities deeper in the Miocene and in older formations.

b. Sumecani 30 miles east of Zagreb also produces from Miocene sands but much shallower (2300 ft). Fourteen wells are producing around 60 tons per day (420 bbl).

c. Mramor Brad 50 miles east of Zagreb is a new field with only 2 wells drilled. One produces from around 3000 ft about 100 bbl per day; the other is dry.

d. Gojilo 60 miles east of Zagreb is an old field completely drilled (at least from the producing level). Its production is around 600 bbl per day.

2. **Serbia.** It is on the Eastern side bordering Rumania and Bulgaria. Information in that new oil province is difficult to obtain. There are at least 3 prospective fields:

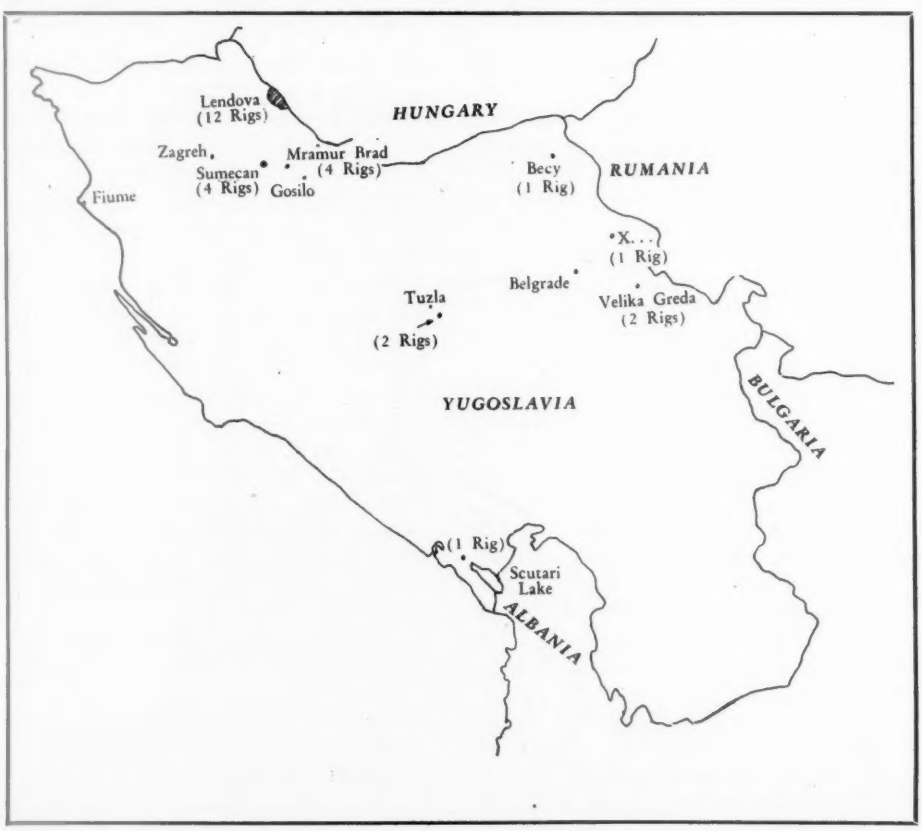
a. Velika Greda (Southeast of Belgrade) has one well drilled to 1200 meters (4000 ft) is a small producer. A second well is testing.

b. Becy in the province of Voyvodina bordering Hungary and Rumania has one gas well.

c. Another prospect with unknown result.

3. **Bosnia.** Two wells are drilling near the town of Tuzla. They have reached some limestone at 2600 ft with sign of production.

Map of Yugoslavia showing locations of drilling rigs, most of them in small fields.



Drilling Activity

A total of 26 rigs are in operation as follows:

Lendova. Twelve rigs; 10 of small capacity, mostly prewar ones, and 2 new Bethlehem rigs, one with a capacity of 17,000 ft. Three additional small Bethlehem rigs are on order. Sumecani has 4 rigs in operation; Mramor Brad, 4; Velika Greda, 2; Becy, 1; X . . ., 1; and, Bosnia, 1.

A new wildcat is to be started soon near the Lake of Scutari (province of Montevegro) with a national portable outfit. The drilling crews are all native crews including pushers. They are good hard working people and absorb readily new techniques and equipment.

Refineries

The refining capacity of Yugoslavia is very small. The main refinery is at Rijeka (Fiume). Most of the products consumed are imported already refined.

Conclusion

Under the Tito regime, Yugoslavia is hard at work building up first its heavy industries including oil. It is severely handicapped particularly by lack of means of communication and transportation. Nevertheless, it will likely manage to fulfill the 5 year plan and it will need, for that, technical and material help from the West. Its leaders are hard, cold traders who pay the price for the equipment purchased but in doing so consider themselves free from any political entanglement. * *

Phenol extraction section of Shell Oil Company's lube oil unit, Houston, Texas.

P 937.3

Catalytic Cracking Units Dominate Refinery Construction in 1949-50

ARCH L. FOSTER*

A TOTAL of 30 catalytic cracking units have been reported as built or being built during the period from January 1, 1949 to May 1, 1950, according to a survey just summarized by *The Petroleum Engineer*. These units include all the currently developed processes, FCC, TCC, Houdriflow, Cycloversion, and a number for which the individual process was not mentioned by reporting companies. Reference to Tables 1 and 2 shows that at least 18 catalytic polymerization units were also constructed or being constructed. In addition, a number of old units are being revamped or their capacities increased.

In the natural gasoline field the expansion of existing facilities is the largest item, 44 plants reporting as being either new or in the throes of major expansion programs. Ten additional plants are undergoing expansion activities in varying degrees; apparently in the majority of cases the additions being in the nature of fractionation facilities or refrigeration units for the recovery of greater amounts of liquefied petroleum gases, propane, and butane. The 'sick' condition of the LPG market as reported more recently indicates that some of this capacity expansion at least may have been ill-timed for the present, without being able to foretell the condition of the industry within a few

*Refining and Gas Processing Editor.

EXCLUSIVE

TABLE 1. REPORT ON CONSTRUCTION IN THE REFINING INDUSTRY, 1949-1950

Company name	Plant location	Type of unit	Daily capacity, (bbl, gal, cu ft, etc.)	When completed	Approximate cost	Built by
Aetna Oil Co.	Louisville, Kentucky	Tanks (4)	2,260 bbl	Jan, 49	$32,200	Chicago Bridge & Iron
Aetna Oil Co.	Louisville, Kentucky	Tank (spheroid) (1)	7,500 bbl	March, 49	$33,900	Chicago Bridge & Iron
Ashland Oil & Refining Co.	Catlettsburg, Kentucky	Poly plant	3,600 bbl	April, 50	$250,000	Staff
Ashland Oil & Refining Co.	Catlettsburg, Kentucky	Copper treater	20,000 bbl	Sept, 49	$60,000	Staff
Ashland Oil & Refining Co.	Catlettsburg, Kentucky	Revamp crude unit	25,000 bbl	July, 49	$520,000	Staff; Cat. Cons. Co.
Ashland Oil & Refining Co.	Canton, Ohio	Crude unit	20,000 bbl	March, 49	$400,000	Cat. Cons. Co.
Ashland Oil & Refining Co.	Canton, Ohio	Revamp crude plant	3,500 bbl	June, 49	$210,000	Cat. Cons. Co.
Ashland Oil & Refining Co.	Canton, Ohio	Light ends & poly plant	Poly 125 bbl	May, 50	$60,000	Catalytic Cons. Co.
British-American Oil Co., Ltd.	Montreal, Canada	Topping	14,500 bbl	Nov. 49	$8,759,000	Canadian
British-American Oil Co., Ltd.	Montreal, Canada	Decarbonizing	4,350 bbl	Nov, 49		Kellogg
British-American Oil Co., Ltd.	Montreal, Canada	FCC	13,500 bbl	Nov, 49		Kellogg
British-American Oil Co., Ltd.	Montreal, Canada	Cat. poly	500 bbl product	Nov, 49		Kellogg
British-American Oil Co., Ltd.	Clarkson, Canada	Propane deasphalting	700 bbl	June, 50	$500,000	Kellogg
British-American Oil Co., Ltd.	Edmonton, Canada	Comb. topping delayed coking & cracking	5,200 bbl	July, 51	$3,500,000	Kellogg
British-American Oil Co., Ltd.	Edmonton, Canada	FCC	2,000 bbl	July, 51		Kellogg
California Refining Co.	Perth Amboy, New Jersey	Cat. cracker	25,000 bbl	Jan, 51		Braun
California Refining Co.	Perth Amboy, New Jersey	Reformer	10,000 bbl	Jan. 51		Braun
California Refining Co.	Perth Amboy, New Jersey	Alkylation	5,000 bbl	Jan, 51		Kellogg
California Refining Co.	Perth Amboy, New Jersey	Crude units	50,000 bbl	Jan, 51		Braun
California Refining Co.	Perth Amboy, New Jersey	Boiler plants	300,000 lb/hr	Jan, 51		Braun
Carter Oil Co.	Billings, Montana	Complete refinery inc. FCC	22,000 bbl	July, 49		Fluor Corp.
Cit-Con Oil Corp.	Lake Charles, Louisiana	Lube	6,000 bbl	Oct, 49	$42,000,000	Lummus-Max B. Miller
Cities Service Oil Co. (Del.)	East Chicago, Indiana	Delayed coker	17,500 bbl	April, 49	$3,900,000	Kellogg
Cities Service Oil Co. (Del.)	East Chicago, Indiana	FCC	14,700 bbl	April, 49	$7,500,000	Kellogg
Cities Service Oil Co. (Del.)	East Chicago, Indiana	Lake water supply		April, 49	$1,500,000	Kellogg
Cities Service Oil Co. (Del.)	East Chicago, Indiana	Power plant		April, 49	$1,400,000	Kellogg
Cities Service Oil Co. (Del.)	East Chicago, Indiana	Auxiliary facilities		April, 49	$3,900,000	Kellogg
Terminal Facilities, Inc.	Cicero, Illinois	Blending plant	1,300 bbl	July, 50	$4,800,000	Sumner S. Sollitt & Co.
Continental Oil Co.	Billings, Montana	Comp. refinery inc. crude topping, propane deasphalting, FCC, & polymerization	7,500 bbl	Nov, 49	$9,300,000	Jones & Laughlin
Continental Oil Co.	Ponca City, Oklahoma	Crude topping	30,000 bbl	Sept, 49	$2,800,000	Bechtel Corp.
Continental Oil Co.	Ponca City Oklahoma	Misc. refinery rev. of lines & tanks, instal. of add. boiler, cooling tower, & treating facilities in connection with the crude topping unit listed under item 2		Jan, 51	$3,000,000	Continental Oil Co.
Cooperative Ref. Associates	Coffeyville, Kansas	Rev. to a TCC unit to convert to solid bed flow with no increase in capacity	No increase	Nov. 50	471,340	Continental Oil Co.
Cooperative Ref. Assoc.	Coffeyville, Kansas	Crude distillation	Revamp cap. from 12,000 bbl to 19,000 bbl	Feb, 49	$150,000	Company
Cooperative Ref. Assoc.	Coffeyville, Kansas	FCC unit	Revamp Plancor unit	July, 49	$150,000	Revamp by UOP & Co.
Cooperative Ref. Assoc.	Coffeyville, Kansas	Gas concen.	Revamp Plancor facilities	July, 49	$35,000	Revamp by UOP & Co.
Cooperative Ref. Assoc.	Coffeyville, Kansas	Poly plant	Former Plancor isom	July, 49	$50,000	Revamp by UOP & Co.
Cooperative Ref. Assoc.	Coffeyville, Kansas	Steam generation	50,000 lb/hr—275 lb/sq in	Dec, 49	$50,000	Erie City
Cooperative Ref. Assoc.	Coffeyville, Kansas	Tanks—4	80,000 bbl	Sept, 49	$225,000	C B & I. Piping by Co.
Cooperative Ref. Assoc.	Coffeyville, Kansas	Cooling tower	7,000 gpm	Sept, 49	$60,000	Water cooling equip.
Cooperative Ref. Assoc.	Coffeyville, Kansas	MEK dewaxing & wax manuf.	2,500 bbl	Dec, 49	$2,000,000	Process Engrs., Dallas
Cooperative Ref. Assoc.	Coffeyville, Kansas	Wax caking	30,000 lb/D.	April, 50		Company
Cooperative Ref. Assoc.	Coffeyville, Kansas	Desalting equipment	20,000 bbl	Contemp.		
Cosden Petroleum Corp.	Big Spring, Texas	FCC UOP design	6,000 bbl	Oct, 49	$2,100,000	Refinery Engr. Co.
Cosden Petroleum Corp.	Big Spring, Texas	Enlargement of aux. facilities		Dec, 49	$300,000	Company
Esso Standard Oil Co.	Bayonne, New Jersey	MEK solvent dewaxing	7,500 bbl	March, 50		E. B. Badger's Sons Co.
Evangeline Ref. Co.	Jennings, Louisiana	Perco cycloversion ref.	400 bbl	Nov, 49		Grebe & Doremus
Excelsior Refineries, Ltd.	Lloydminster, Alberta, Canada	Vacuum	1,500 bbl	Aug, 50		Koch Engr.
The Frontier Refining Co.	Cheyenne, Wyoming	Coke	2,450 bbl	June, 50	$750,000	The Refinery Engr. Co.
Gas & Oil Refineries, Ltd.	Hartell, Alberta, Canada	TCC	1,500 bbl		$320,000	Sparling-Davis Co.
General Pet. Corp.	Torrance, California	TCC furnace	4,000 bbl	March, 49		Lummus
General Pet. Corp.	Torrance, California	Coke unit	7,500 bbl	Feb, 50		Bechtel
General Pet. Corp.	Torrance, California	H2S absorber	55 ton/day	March, 50		Badger
General Pet. Corp.	Torrance, California	TCC furnace	4,000 bbl	April, 50		Ref. Maintenance Co.
The Globe Oil & Refining Co.	Lemont, Illinois	FCC	6,000 bbl	Jan, 50		Company
Gulf Refining Co.	Toledo, Ohio	Top. & vac.	32,000 bbl	May, 49		E. B. Badger & Sons
Gulf Refining Co.	Toledo, Ohio	Cat. crk.	15,500 bbl	Sept, 49		M. W. Kellogg Co.
Gulf Refining Co.	Toledo, Ohio	UOP poly	5,000 bbl (charge)	Aug, 49		M. W. Kellogg Co.
Gulf Refining Co.	Cleves, Ohio	Cat. crk.	15,500 bbl	Sept, 49		M. W. Kellogg Co.
Gulf Refining Co.	Cleves, Ohio	UOP poly	5,000 bbl (charge)	Sept, 49		M. W. Kellogg Co.
Gulf Oil Corp.	Philadelphia, Pennsylvania	Top. & vac.	30,000 bbl	Sept, 49		Lummus Co.
Hi-way Refineries, Ltd.	Saskatoon, Saskatchewan, Canada	Topping	2,000 bbl	Dec, 49	$850,000	Refinery Engr. Co.
Hi-way Refineries, Ltd.	Saskatoon, Saskatchewan, Canada	Dubbs thermal cracking	600 bbl	Dec, 49		
Humble Oil & Refining Co.	Baytown, Texas	Pipe still	60,000 bbl	Aug, 49	$5,600,000	Foster-Wheeler
Imperial Oil, Ltd.	Winnipeg, Manitoba, Canada	Crude pipe still & FCC	10,000 bbl	Contract let		Canadian Kellogg, Ltd.
Indiana Farm Bureau Coop., Inc.	Mt. Vernon, Indiana	UOP FCC	3,640 bbl	Dec, 50	$1,260,500	UOP & Ref. personnel
Indiana Farm Bureau Coop., Inc.	Mt. Vernon, Indiana	Gas concen. unit		Dec, 50	$446,200	UOP & Ref. personnel
Indiana Farm Bureau Coop., Inc.	Mt. Vernon, Indiana	Poly. unit	300 bbl	Dec, 50	$90,500	UOP & Ref. personnel
Indiana Farm Bureau Coop., Inc.	Mt. Vernon, Indiana	Vacuum unit	4,000 bbl	Dec, 50	$333,200	UOP & Ref. personnel
Lion Oil Co.	El Dorado, Arkansas	Naphtha rerun	1,200 bbl	2nd qtr, 50	$153,000	Lion Oil
Lion Oil Co.	El Dorado, Arkansas	Vacuum unit	7,000 bbl	June, 49	$212,400	Lion Oil
Lion Oil Co.	El Dorado, Arkansas	Asphalt specialties plant		March, 49	$157,600	Lion Oil
McNutt Oil & Ref. Co., Inc.	Brickland, New Mexico	Revamp thermal cracker	1,200 bbl	Sept, 49	$150,000	Company
Mercury Oil Refining Co.	Oklahoma City, Oklahoma	Crude oil	5,000 bbl	March, 49	$350,000	Refinery Engr. Co.
M.F.A. Oil Co.	Chanute, Kansas	Perco desulfurization	1,000 bbl	Nov, 49	$80,000	Koch Engr. Co.
North Star Oil, Ltd.	St. Boniface, Canada	General revamping		Nov, 49	$400,000	UOP & Co.
The Ohio Oil Co.	Muncie, Indiana	Ref. prod. terminal	100,000 gals.	Feb, 50		Michael & Poling
The Ohio Oil Co.	Lima, Ohio	Ref. prod. terminal	200,000 gals.	June, 50		Poling & Bacon
Old Dutch Ref. Co.	Muskegon, Michigan	UOP platformer	1,500 bbl reactor charge 2,000 bbl total charge	Oct, 49	$750,000	UOP Engr., Company
Osceola Refining Co.	Reid City, Michigan	Desalter	3,000 bbl	Jan, 50	$6,500	Petreco
Pan American Refining Corp.	Texas City, Texas	Resin unit in chemicals plant		March, 49		Company
Pan American Refining Corp.	Texas City, Texas	Petreco crude desalting facilities at TC unit No. 3	30,000 bbl crude	June, 49		H. K. Ferguson Co.
Pan American Refining Corp.	Texas City, Texas	Facilities at TC unit No. 2	50,000 bbl crude	Sept, 49		Tellepsen Co., Lummus Co., Chicago Bridge & Iron Co., Company
Pan American Refining Corp.	Texas City, Texas	Turbo-generator at power sta.	3,000 Kw	Nov, 49		Company
Pan American Refining Corp.	Texas City, Texas	Process laboratory building		April, 50		Ferguson Co., Company
Pan American Refining Corp.	Texas City, Texas	H2S removal facilities	19 x 10^6CFD refinery gas	May, 50		Tellepsen Co.
Pan American Refining Corp.	Texas City, Texas	Changes to FCC unit	34,000 bbl gas, oil	May, 50		Company
Pan-Am Southern Corp.	El Dorado, Arkansas	Delayed coking	9,300 bbl	Oct, 50, Aprx.		Lummus Co.
Panhandle Prod. & Ref. Co.	Wichita Falls, Texas	UOP FCC	1,500 bbl	Feb, 50	$1,000,000	Jones & Laughlin
Pennzoil Co.	Rouseville, Pennsylvania	Deresining unit	1,370 bbl	Late 50		M. W. Kellogg Co.
Petrol Refining, Inc.	Texas City, Texas	Crude	60,000 bbl	June 49	$1,300,000	Rust Engr. Co.
Petroleum Specialties, Inc.	Flat Rock, Michigan	Crude fract. col.	6,000—7,000 bbl	Fall 49	$50,000	Staff
Petroleum Specialties, Inc.	Flat Rock, Michigan	Tankage	30,000 bbl	Fall, 49	$30,000	Hammond
Phillips Oil Co.	Kansas City, Kansas	Lub oil	1,500 bbl	June ,49		M. W. Kellogg Co.
Phillips Oil Co.	Kansas City, Kansas	Cat. poly.	1,500 bbl	Sept, 49		C. F. Braun & Co.
Phillips Oil Co.	Kansas City, Kansas	Cat. cracker	24,000 bbl	Jan, 50		C. F. Braun & Co.
Phillips Oil Co.	Okmulgee, Oklahoma	Cat. poly.	150 bbl	May, 50		Phillips Oil Co.

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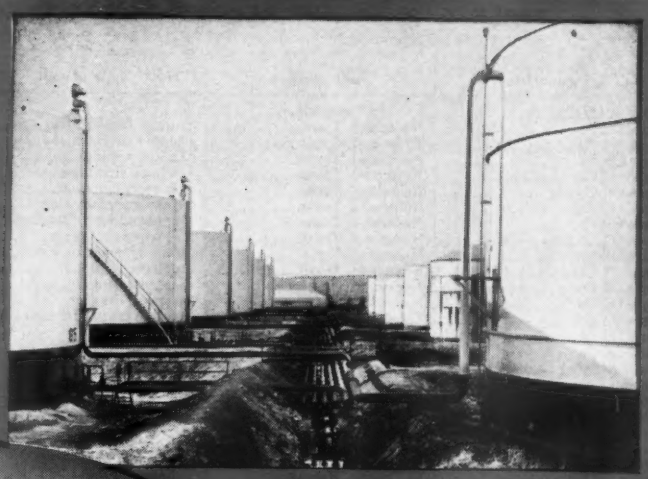

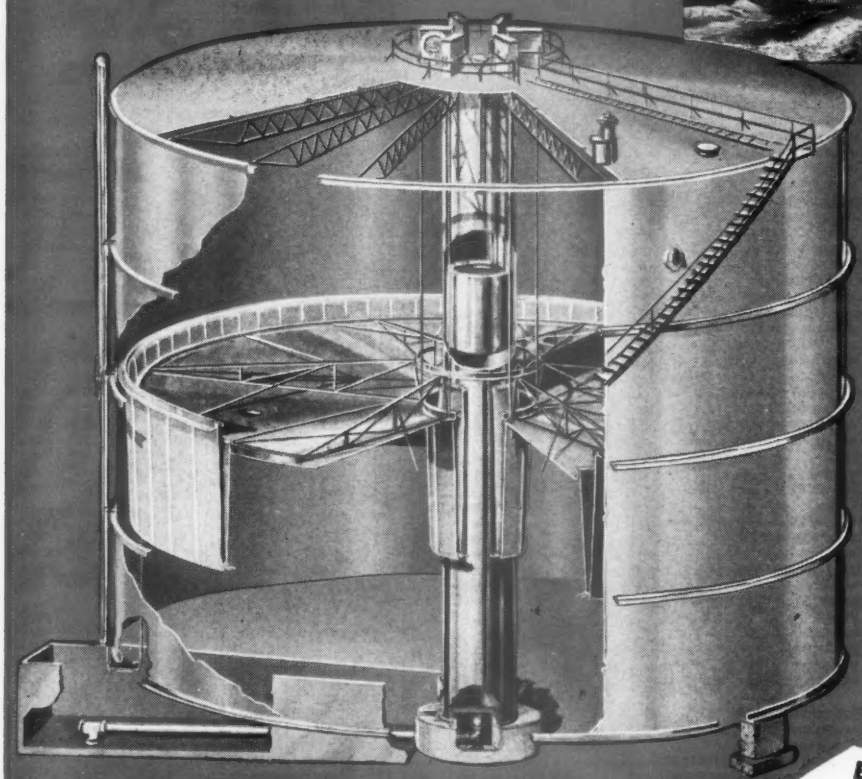

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TABLE 1. (Continued) REPORT ON CONSTRUCTION IN THE REFINING INDUSTRY, 1949-1950

Company name	Plant location	Type of unit	Daily capacity, (bbl, gal, cu ft, etc.)	When completed	Approximate cost	Built by
Phillips Oil Co.	Eastern Venesuela	Wax plant	Over 2,000,000 lb of wax/yr	1952		
Pure Oil Co.	Nederland, Texas	Propane deasphalting	2,600 bbl	Feb, 49		Kellogg
Pure Oil Co.	Nederland, Texas	Phenol extraction	4,320 bbl	Feb, 49		Kellogg
Pure Oil Co.	Nederland, Texas	MEK dewaxing	3,074 bbl	March, 49		Lummus
Pure Oil Co.	Nederland, Texas	Contract filtration	2,100 bbl	March, 49		Lummus
Pure Oil Co.	Nederland, Texas	Wax recrystallation	200 bbl	March, 50		Lummus
Pure Oil Co.	Nederland, Texas	Grease manufacturing	24,000,000 lb/yr	March ,49		Stone & Webster
Pure Oil Co.	Nederland, Texas	Compounding & blending	1,486,000 bbl/mo.	March, 49		Stone & Webster
Pure Oil Co.	Nederland, Texas	2 Floating roof tanks	180,000 bbl ea.	March, 50		Chicago Bridge & Iron
Pure Oil Co.	Nederland, Texas	Steel and concrete wharf	1,200 ft long	March, 49		Stone & Webster
Pure Oil Co.	Nederland, Texas	Cafeteria		July, 49		Austin
Pure Oil Co.	Nederland, Texas	Electrical desalter	27,000 bbl	April, 49		Ellerbee
Pure Oil Co.	Nederland, Texas	Electrical desalter	18,000 bbl			Ellerbee
Pure Oil Co.	Toledo, Ohio	Gasoline treater for sour crude	19,8000 bbl	May, 49		Graver
Pure Oil Co.	Toledo, Ohio	Girbitol unit	5,857,000 cu ft	April, 49		Graver
Pure Oil Co.	Toledo, Ohio	1 Floating roof tank	180,000 bbl	Oct, 49		Chicago Bridge & Iron
Rado Refining Co.	McAllen, Texas	Skimming plant	3,000 bbl		$100,000	Koch
Republic Oil	Texas City, Texas	Poly	1,000 bbl	May, 49	$200,000	Company
Rock Island Refining Corp.	Rock Island, Indiana	Cat. cracker	5,000 bbl	Aug, 49		Company
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Solutizer plant	7,000 bbl	April, 50		Shell
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Cat. cracking	10,000 bbl	Late 50		A. G. McKee Co.
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Cat. poly unit, etc.		Late 50		Fluor Corp.
Sherwood Refining Co.	Gretna, Louisiana	Wax specialties		June, 50		
Skelly Oil Co.	El Dorado, Kansas	Refinery modern. FCC & aux.	35,000 bbl	June, 50		M. W. Kellogg
Socony-Vacuum Oil Co., Inc.	Casper, Wyoming	TCC & modernisation	6,900 bbl	April, 49		Catalytic Constr. Co.
Socony-Vacuum Oil Co., Inc.	E. St. Louis, Illinois	Crude distillation	15,000 bbl	Nov, 49		Bechtel
Socony-Vacuum Oil Co., Inc.	E. St. Louis, Illinois	Gasoline treating	18,000 bbl	June ,49		Bechtel
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	Crude distillation	19,500 bbl	Fall, 49		Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	Furfural refining	4,450 bbl	Mid, 49		Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	Contact filtration	3,000 bbl	Late, 49		Badger
Socony-Vacuum Oil Co., Inc.	Casper, Wyoming	Topping unit revisions	5,900 bbl	1st Qtr, 50		Catalytic Constr. Co.
Socony-Vacuum Oil Co., Inc.	Augusta, Kansas	Houdry conversion to TCC	15,000 bbl	Late, 50		Fluor
Socony-Vacuum Oil Co., Inc.	Trenton, Michigan	Houdry conversion to TCC	15,000 bbl	Late, 50		Braun
Socony-Vacuum Oil Co., Inc.	E. St. Louis, Illinois	Thermal cracking	13,200 bbl	Jan, 50		Bechtel
Socony-Vacuum Oil Co., Inc.	E. St. Louis, Illinois	Delayed coker	8,000 bbl	Mar, 50		Bechtel
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	Propane deasphalting	5,950 bbl	2nd Qtr, 50		Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	MEK dewaxing	2,050 bbl	1st Qtr, 50		Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	Light oil treating	28,000 bbl	1st Qtr, 50		Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, New Jersey	Modernizing comp. & pkg. dept.	5,000 bbl	Jan, 50		Socony-Vacuum
Somerset Ref., The	Somerset, Kentucky	Solvent rec. tower	100 bbl	April, 50	$10,000	Company
Standard Oil Co. (Indiana)	Whiting, Indiana	Aux. facilities		1949		Fluor
Standard Oil Co. (Indiana)	Casper, Wyoming	Cat. cracker	8,000 bbl	Feb, 49		Kellogg
Standard Oil Co. (Ohio)	Lima, Ohio	FCC	20,000 bbl	Oct, 49	$6,600,000	McKee
Standard Oil Co. (Ohio)	Lima, Ohio	Mercaptan extraction	10,000 bbl	Jan, 50	400,000	McKee
Standard Oil Co. (Ohio)	Lima, Ohio	Crude coker	15,000 bbl	March, 50	$5,000,000	Kellogg
Standard Oil Co. (Ohio)	Lima, Ohio	Propane deasphalting	1,500 bbl	March, 50	$800,000	Kellogg
Standard Oil Co. (Ohio)	Lima, Ohio	Vacuum distillation	9,000 bbl	May, 50	$1,500,000	Lummus
Standard Oil Co. (Ohio)	Lima, Ohio	MEK	3,300 bbl	July, 50	$4,000,000	Lummus
Standard Oil Co. (Ohio)	Lima, Ohio	Furfural	4,500 bbl	July, 50	$2,500,000	Lummus
Standard Oil Co. (Ohio)	Lima, Ohio	Clay contact	2,500 bbl	July, 50	$750,000	Lummus
Standard Oil Co. (Ohio)	Cleveland, Ohio	TCC	18,000 bbl	Nov, 50	$3,600,000	Bechtel
L. Sonneborn Sons	Petrolia, Pennsylvania	Anti-pollution construction		June, 50	$150,000	Kean-Wise, Sewickly
L. Sonneborn Sons	Petrolia, Pennsylvania	Acid sludge rec'y plant		June, 50	$225,000	Chemical Const. Co.
L. Sonneborn Sons	Petrolia, Pennsylvania	Tanks		June, 50	$50,000	Refinery crew
L. Sonneborn Sons	Franklin, Pennsylvania	Refrigeration plant		June, 50	$125,000	Refinery crew
Sun Oil Co.	Marcus Hook, Pennsylvania	Packaging plant				W. W. Lindsay & Sun
Sun Oil Co.	Marcus Hook, Pennsylvania	Expansion of fire protection syst.				Company
Sun Oil Co.	Toledo, Ohio	Crude topping & cat. crk. facilities consists of: Gas comp. unit, gasoline recovery unit, cat. poly. unit, crude topping unit, vac. flash unit, cat. crk. unit	30,000 bbl cracking 30,000 bbl crude			Catalytic Constr. Co.
Sun Oil Co.	Marcus Hook, Pennsylvania	Wax refining plant		Dec, 49		Sun Oil Co.
Sun Oil Co.	Chacahoula, Louisiana	Compressor plant	2,500 MCF	Feb, 49		J. F. Pritchard Co.
Sun Oil Co.	Marcus Hook, Pennsylvania	Oil storage tanks	600,000 bbl	Aug, 49		Chicago Bridge & Iron
Sun Oil Co.	Marcus Hook, Pennsylvania	Crude oil hdlg. wharves to stge.		Aug, 49		Company
Shamrock Oil & Gas Co.	Sunray, Texas	Gas oil cracker (cycloversion)	2,000 bbl	Feb, 50		Company
Shamrock Oil & Gas Co.	Sunray, Texas	Cat. poly	400 bbl	March, 50		Company
The Texas Co.	Westville, New Jersey	Complete new refinery inc. atmospheric crude topping & vac. pipe still, FCC, thermal reformer, cat. poly. unit & auxiliaries	40,000 bbl crude	Dec, 49		Foster-Wheeler, Kellogg
The Texas Co.	Tulsa, Oklahoma	Expansion and modernisation of existing refinery. New facilities include atmospheric crude topping and vac. pipe still, FCC, cat. poly. and auxiliaries	30,000 bbl crude	Dec, 49		Foster-Wheeler, Kellogg
The Texas Co.	Port Arthur, Texas	Expansion of lube oil facilities inc. atmospheric crude topping and vac. pipe still, solvent dewaxing furfural refining and aux.	37,500 bbl crude 2,500 bbl finished lube	July, 49		Foster-Wheeler
The Texas Co.	Beacon, New York	Expansion of research lab.		Dec, 49		Voorhees, Walker, Foley & Smith
The Texas Co.	Lawrenceville, Illinois	Expansion, inc. atmospheric crude topping and vac. pipe still, FCC, cat. poly. and additions to aux.	20,000 bbl crude	April, 51		Foster-Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumright, Oklahoma	Houdriflow cat. cracking	4,000 bbl	April, 50		Process Engr.
Union Oil Co. of California	Wilmington, California	H_2S recovery facilities	30,000 lb	April, 49	$350,000	Erhart & Arthur, Fluor
Union Oil Co. of California	Oleum, California	Revisions to lube dewaxing fac.	1,900 bbl	April, 49	$2,600,000	M. W. Kellogg
Union Oil Co. of California	Oleum, California	Duo sol	6,000 bbl	Sept, 49	$3,300,000	Max B. Miller
Union Oil Co. of California	Oleum, California	Asphalt & refined oil loading fac.		Oct, 49	$500,000	Fred J. Early, Jr.
Union Oil Co. of California	Oleum, California	Additions to main office shops & miscellaneous buildings		Jan, 50	$1,000,000	McKittrick, Parker, Steffens & Pearce
Union Oil Co. of California	Oleum, California	Revisions to crude refinery facilities and utilities		Feb, 50	$4,000,000	Refinery Mntce. Co.
Union Oil Co. of California	Oleum, California	Improvements to compound and barrel handling facilities		Feb, 1950	$1,490,000	F. J. Early, Jr., C. N. Peterson, Mathews
Union Oil Co. of California	Oleum, California	Fuel oil tankage & transf. facilities		March, 50	$1,800,000	Eaton and Smith Chicago Bridge & Iron Utah Construction
Union Oil Co. of California	Near Brea, California	Research facilities		July, 51	$5,000,000	P. J. Walker
Vickers Pet. Co.	Potwin, Kansas	Revamp poly. plant	250 bbl	March, 50	$100,000	Ref. Engr.
Vickers Pet. Co.	Potwin, Kansas	Reforming	1,000 bbl	March, 50	$100,000	Company
Vickers Pet. Co.	Potwin, Kansas	Desalting	6,000 bbl	May, 50	20,000	Company
Vickers Pet. Co.	Potwin, Kansas	Oil separator		April, 50	$20,000	Ref. Engr.
Western Asphalt & Refining Co.	Santa Maria, California	Topping & asphalt	1,500 bbl	Feb, 50	$75,000	Company
Wilshire Oil Co., Inc.	Norwalk, California	H_2S removal unit	4 tons of H_2S	March, 50	$100,000	Fluor
Wilshire Oil Co., Inc.	Norwalk, California	UOP, poly	400 bbl of poly	May, 50	$150,000	Company

TABLE 2. REPORT ON CONSTRUCTION IN THE NATURAL GASOLINE INDUSTRY.

Company name	Plant location	Type of unit	Daily capacity (cu ft, etc.)	When completed	Approximate cost	Built by
American Republics Corp.	Joe's Lake, Tyler Co., Texas	2 absorbers (added)	10,000 mcf	June, 50	$125,000	Gasoline Plt. Const. Corp
Atlantic Refining Co. et al, The	Crane Co., Texas	Pressure maintenance	8,240 mcf gas processed 22,680 gal liquid production	July, 49	$1,250,000	Hudson
California Co., The; Roeser & Pendleton, Stanolind Oil & Gas, Danciger Refining, Hunt Oil Co., et al.	Brookhaven, Mississippi	Gasoline plant	10,000 mcf	July, 49	$750,000	Hudson
California Co., The; Phillips Petroleum Co.	Ruston, Louisiana	Gasoline plant	100,000 mcf	Feb, 49	$3,300,000*	Hudson
Carthage Corporation	Carthage, Panola Co., Texas	Gas processing	385,000 mcf	April, 49	$5,500,000	Hudson
Chicago Corp., The	Carthage, Texas	Natural gasoline	210,000 mcf	June, 49	$2,250,000	Fish
Cisco Hydrocarbon Corp.	Cisco, Texas	Refrigeration addition to plant		March, 50	$30,000	Company
Cisco Hydrocarbon Corp.	Cisco, Texas	2300 HP Clark field boosters		Feb. 50	$ 75,000	Company
Cisco Hydrocarbon Corp.	Cisco, Texas	Field line additions		April, 50	$15,000	Company
Cities Service Oil	Pampa, Texas	Rebuild gasoline plant	18,000 mcf	July 49		Walco
Cities Service Oil	Chico, Texas	Gasoline plant	12,000 mcf	Jan, 50		Fluor
Cities Service Oil	Cicero, Illinois	Compound plant	1,200 bbl	July, 50		Sollitt
Coastal Refineries, Inc.	McAllen, Texas	Cycling	75,000 mcf	March, 50		
Coline Gasoline Corporation	Rincon-Ventura Co., California	Improvements to absorp. plant Deethanizer, air cooling, propane production	15,000 mcf 50,000 gal	March, 50	$500,000	Ref. Maintenance Co.
Continental Oil Co.	Rio Grande City, Texas	Five Add'l. Clark's compressors & absorption refrigeration	20,000 mcf 31,500 gal	March, 50	$1,297,000	Jones & Laughlin
Continental Oil Co.	Big Lake, Texas	Gasoline plant & four Cooper-Bessemer compressors	9,300 mcf 85,000 gal	Pending	$2,854,000	Ref. Maintenance Co.
Continental Oil Co.	Nordheim, Texas	Four Clark's compressors	10,800 mcf	April, 50	$600,000	Process Engineers
Continental Oil Co.	Ventura, California	Absorption refrig. & deethanizer	23,000 mcf 45,500 gal	May, 50	$500,000	Ref. Maintenance Co.
Del Rey Petr. Co.	Eagle Lake, Texas	Dehydration	25,000 mcf	March, 50	$650,000	O. L. Olsen
Gulf Oil Corp.	Penwell, Texas	Absorp.	40,000 mcf	Aug, 49	$6,500,000	C. F. Braun, & Boden
Gulf Oil Corp.	1 mi SE Eunice, New Mexico	Absorp. nat. gasoline plant	43,000 mcf	Aug, 49	$7,000,000	Hudson
Gulf Oil Corp.	1 mi East of Kiefer, Oklahoma	Absorp. nat. gasoline plant	12,000 mcf	Oct, 49	$153,000	Gulf Oil Corp.
Hope Natural Gas Co.	Hastings	Two 300 HP compressors & Jkt. water cooling systems were added to this plant during 1948 & 1949. Natural gasoline recovery plant general additions to present plt.	50,000 gal nat. gasoline 100,000 gal LPG	Sept, 49	$225,000	Company
Humble Oil & Refining Co.	Pickton, Texas	New plant	18,000	Aug, 49		
Humble Oil & Refining Co.	Opelousas, Louisiana	New plant	110,000	Nov, 49		
Humble Oil & Refining Co.	Anahuac, Texas	Additions to plant	55,000	June, 49		
Humble Oil & Refining Co.	Conroe, Texas	Additions to plant	16,000	Nov, 49		
Humble Oil & Refining Co.	Tomball, Texas	Additions to plant	13,000	Dec, 49		
Magnolia Pet. Co. (Seeligson)	Premont, Texas	†HCs and cycling	70,000 mcf 500,000 gal	1949		Hudson
Magnolia Pet. Co. (Hickok)	Ulysses, Kansas	CH.	134,000 mcf 85,000 gal	1949		Walco
Magnolia Pet. (Sholem Alechem)	Countyline, Oklahoma	CH.	30,000 mcf 75,000 gal	Early 1950		Jones & Laughlin
Magnolia Pet. Co. (Chitwood)	Ninnekah, Oklahoma	**CH and cycling	13,000 CH 57,000 gal 12,000 Cycle	1950		Construction Serv. Co.
Molyamer Cooperative	Lea County	Fat.	10,000 mcf	Dec, 49		L. S. Gregory
Repressuring Agreement	Molyamar field	Oil deethanizer	30,000 gal		$100,000	R. L. Purven
McKamie Gas Cleaning Co.	McKamie, Arkansas	Gasoline plant enlargement	25,000 mcf increase	Jan, 51	$1,465,000	Jones & Laughlin
Northern Natural Gas Co.	Sublette, Kansas	Absorption (add'l. equipment)	265,000 mcf	March, 50	$350,000	J. F. Pritchard & Co.
Odessa Natural Gasoline Co.	Foster Field	Absorption plant enlargement	30,000 mcf or 55,000 gal gasoline & LPG	May, 49	$1,200,000	Jones & Laughlin
Phillips Pet. Co.	Edmond, Oklahoma	Addn. to natural gasoline	15,000 mcf	April, 50		Refinery Maintenance
Phillips Pet. Co.	Guymon, Oklahoma	Natural gasoline	173,000 mcf	Sept, 49		Phillips
Phillips Pet. Co.	Goldsmith, Texas	Addn. to natural gasoline	40,000 mcf	May, 49		Phillips
Phillips Pet. Co.	Dumas, Texas	Addn. to natural gasoline	45,000 mcf	Jan, 50		Phillips
Plymouth Oil Co.	Rankin, Texas	Clark compressors	85,000 mcf	Jan, 50	$6,500,000	Hudson
Pure Oil Co.	Worland, Wyoming	Natural gasoline addn.	20,000 mcf	March, 50		Braun
Matfield Oil Corp.	Cuyama, California	Absorption	15,000 mcf 111,000 gal	Oct, 49	$3,800,000	Fluor
Richfield Oil Corp.	Cuyama, California	Absorption	30,000 mcf 139,000 gal	Mid, 50	$5,800,000	Fluor
Shell Oil Co. Wasson Plant	Denver City, Texas	Compression absorption	24,000 mcf	4th Qtr., 49		Fluor
Shell Oil Co., TXL Plant	Notrees, Texas	Compression absorption	45,000 mcf	4th Qtr., 49		Brown & Root
Shell Oil, Provident City Plant	Sheridan, Texas	Stripping dehydration	60,000 mcf	2nd Qtr., 50		Fluor
Skelly Oil Co.	Eunice, New Mexico	Compression & absorption		May, 49		Groninger & King
Skelly Oil Co.	Skellytown, Texas	Fractionation		Oct, 49		J. E. Carlson
Skelly Oil Co.	Athens, Louisiana	Gathering System		Nov, 49		Ulmer & Hubbard
Skelly Oil Co.	Bay City, Texas	Gathering System		Nov, 49		Groninger & King
Skelly Oil Co.	Skellytown, Texas	Repressuring		Aug, 50		
Skelly Oil Co.	Skellytown, Texas	Repressuring		March, 51		
Standard Oil Co., (Texas)	Snyder, Texas	Absorption plant	30,000 mcf	Mid, 50	$2-3,000,000	
△Stanolind Oil & Gas & others	Sundown, Texas	Gasoline plant	90,000 mcf	Feb, 49		Braun
△Stanolind Oil & Gas & others	Elk Basin, Wyoming	Gasoline, Sulfur plant	12,000 mcf	March, 49		Stone-Webster
△Stanolind Oil & Gas Co.	Ulysses, Kansas	Gasoline plant	100,000 mcf	Feb, 49		Jones & Laughlin
△Stanolind Oil & Gas & others	Pettus, Texas	Cycling plant	166,000 mcf	July, 49		Jones & Laughlin
△Stanolind Oil & Gas & others	Levelland, Texas	Gasoline plant	40,000 mcf	January, 50		Brown & Root
△Stanolind Oil & Gas & others	Andrews, Texas	Gasoline plant	38,000 mcf	Feb, 50		Jones & Laughlin
△Stanolind Oil & Gas & others	North Cowden, Texas	Gasoline plant	75,000 mcf	April, 50		Stearns-Roger
Sun Oil Co.	Starr County, Texas	Natural gasoline plant	35,000 mcf	July, 49		Petroleum Engr., Inc.
Sun Oil Co.	Coke County, Texas	Natural gasoline plant	10,000 mcf	Sept, 49		J. F. Pritchard Co.
Sun Oil Co.	McAllen, Texas	Absorption	35,000 mcf 102,000 gal	July, 49	$7,378,000	Petroleum Engr.
Sun Oil Co.	Coke County	Compression	10,000 mcf 40,000 gal	Sept, 49	$2,095,000	J. F. Pritchard
Texas Natural Gasoline Corp.	Abilene, Texas	Absorption	13,000 mcf 88,000 gal	Oct, 48		Company
Texas Natural Gasoline Corp.	Gainesville, Texas	Absorption	5,000 mcf 50,000 gal	Sept, 49		Company
TNGC & Santa Rosa Gas Prod.	Grandfalls, Texas	Absorption	30,000 mcf 30,000 gal	Feb, 50		Company
TNGC & Upton Gas Prod. Co.	Rankin, Texas	Absorption	55,000 mcf 200,000 gal	Jan, 50		Company
United Fuel Gas Co. & Virginian Gas & Oil Co.	Hubball, West Virginia	Oil absorption	45,000	April, 49	$600,000	Company
Universal Gasoline Co.	Madell, Oklahoma	Absorption	6,000 mcf	Feb, 49		Company
Warren Pet. Corp.	Wichita Falls, Texas	Absorption, compression	6 mcf	July, 49		Walco
Western Gulf Oil Co. (Paloma Unit)	Bakersfield, California	Hi-press. absorp. cycling plant	*60,000 mcf	May, 50	$4,500,000	C. F. Braun
Garvin County Plants (Warren, Carter, Cities Service, Texas, and J. E. Crosbie)	Maysville	Absorption & compression	90 mcf	July, 49		Dresser

*This item is an increase of 60,000 mcf/da. over the present plant capacity of 65,000 mcf/da.

†Cycle portion of plant expected to be completed 1950.

**Hydrocarbon recovery by absorption process.

△Jointly owned plant, operated by Stanolind Oil and Gas Company.

years. Nationwide expansion of both LPG and natural gas markets going on at present may or may not reverse the trend in the not too distant future.

Surprisingly enough, the great increase in construction of thermal cracking and reforming units is greater than might be prophesied in the face of the obvious trend toward catalytic units. Thirteen thermal crackers include mainly delayed coking and similar processes, and the revamping of old units to fit them for this type of operation. Reasons for this are generally obvious; the disastrous slump in the consumption of heavy residual fuel oil, which for years has consumed the greater portion of cracking and topping still heavy residues, is forcing the refineries to eliminate this product as far as possible from their operation. The preponderance of diesel-electric and therefore of distillate fuel oil-burning locomotives in use and on order (more than 95 per cent of all locomotives on order are diesel-electrics) show the refiner definitely the handwriting on the market wall.

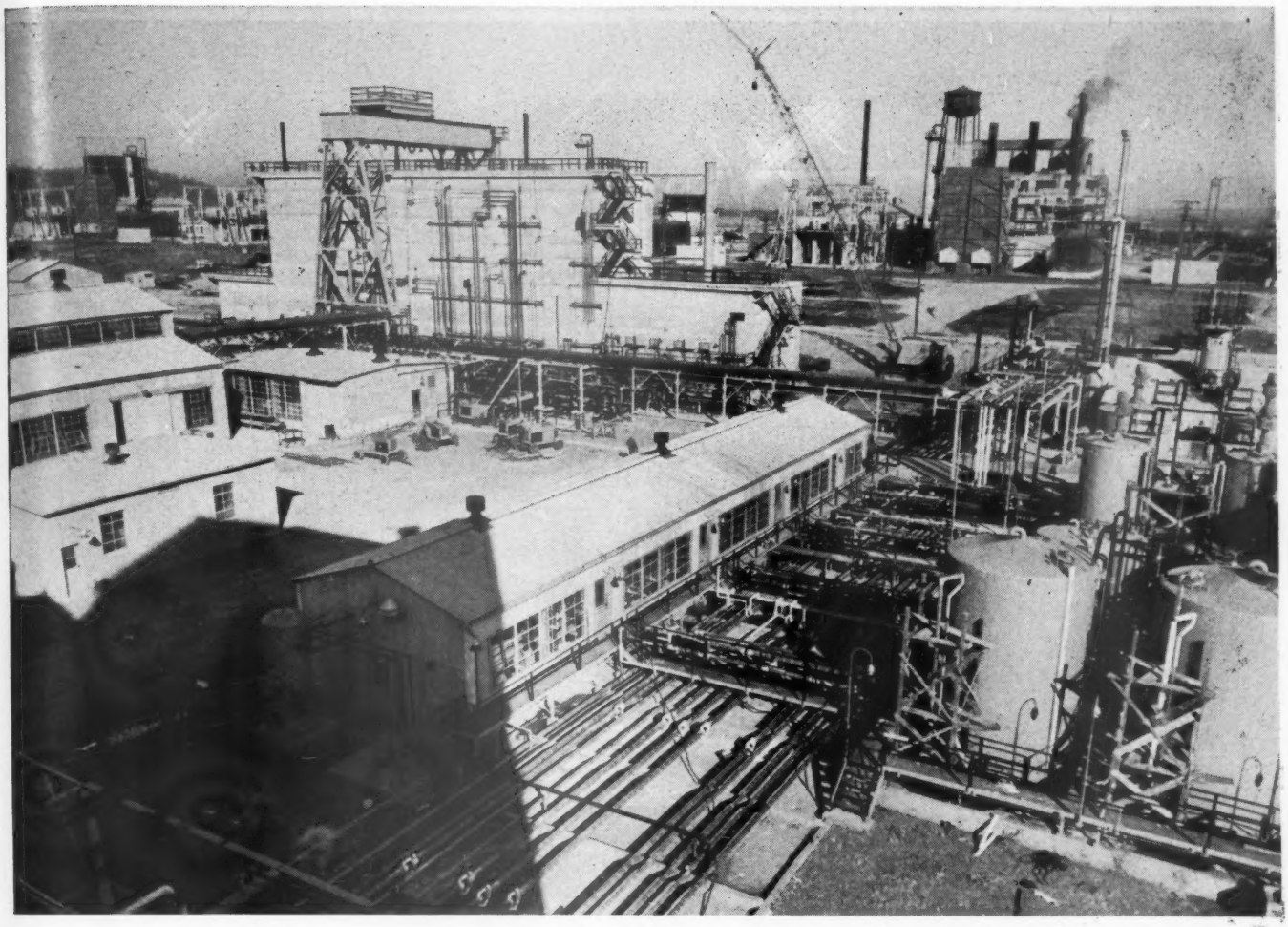
Along these lines the number of distillation and feed preparation units erected and in the process of being erected reaches a total of 23 or more. These units are for the purposes of handling more crude, of preparing feed stocks for catalytic crackers, as well as for the 20 lubricating oil plants or plant units that are new. In the case of the latter group of plants and units, atmospheric-vacuum installations are most common, such as those in the large plants of Cit-Con Corporation at Lake Charles, Louisiana, of Pure Oil Company at Nederland, Texas; Sinclair, and others. Some topping-vacuum units such as, presumably, that of Gulf Oil Corporation at Toledo, are installed for the purpose of extracting the greatest percentage of middle distillates as catalytic charge stocks, furnace, and other distillate fuel oils. A total of three catalytic reformer units are reported, including two Cycloversion installations and the widely publicized and closely watched Platforming unit at Old Dutch Refining at Muskegon, Michigan, employing metallic platinum as catalyst.

Especially interesting is the trend toward smaller catalytic units among those recently completed or yet building. Among these smaller units are the Cosden Fluid plant designed for 6000 bbl per day of charge; Rock Island Refining of Indianapolis, for 5000 bbl per day; IFBC (Cooperative of Mt. Vernon, Indiana), for 3640 bbl per day; Tide Water's Houdriflow just completed for 4000 bbl per day; and the midget of the family, Panhandle Oil and Refining Company's 1500-bbl per day, UOP FCC unit now undergoing 'final' test at Wichita Falls. Among those contracted for recently is the small Houdriflow unit for Shamrock for its Sunray plant, and a rumored unit for Deep Rock at Cushing, Oklahoma.

Total expenditures for these units extend well toward the realm of conjecture. For 85 refinery units of all types, a total cost of about $162,000,000 is reported; of the total of nearly 200 refinery units reported, by extrapolation the possible amount may be as high as $340,000,000 for refining alone. For natural gasoline industry expenditures, 31 units have reported spending $67,000,000 for all types of units. Extrapolating again, the total number of more than 70 units reported may have cost as much as $155,000,000. These 'extrapolated' values are of doubtful dependability.

* * *

Aerial view of Standard of California's refinery in Bakersfield, California.



Back of converter stalls at the Coal Hydrogenation Demonstration Plant of the Bureau of Mines at Louisiana, Missouri. Buildings, left to right, are the high-pressure pump house, instrument house, and heavy-oil pump house. Former Missouri Ordnance Works in background. —*Bureau of Mines photo.*

SYNTHETIC FUEL PRODUCTION

W. C. SCHROEDER*

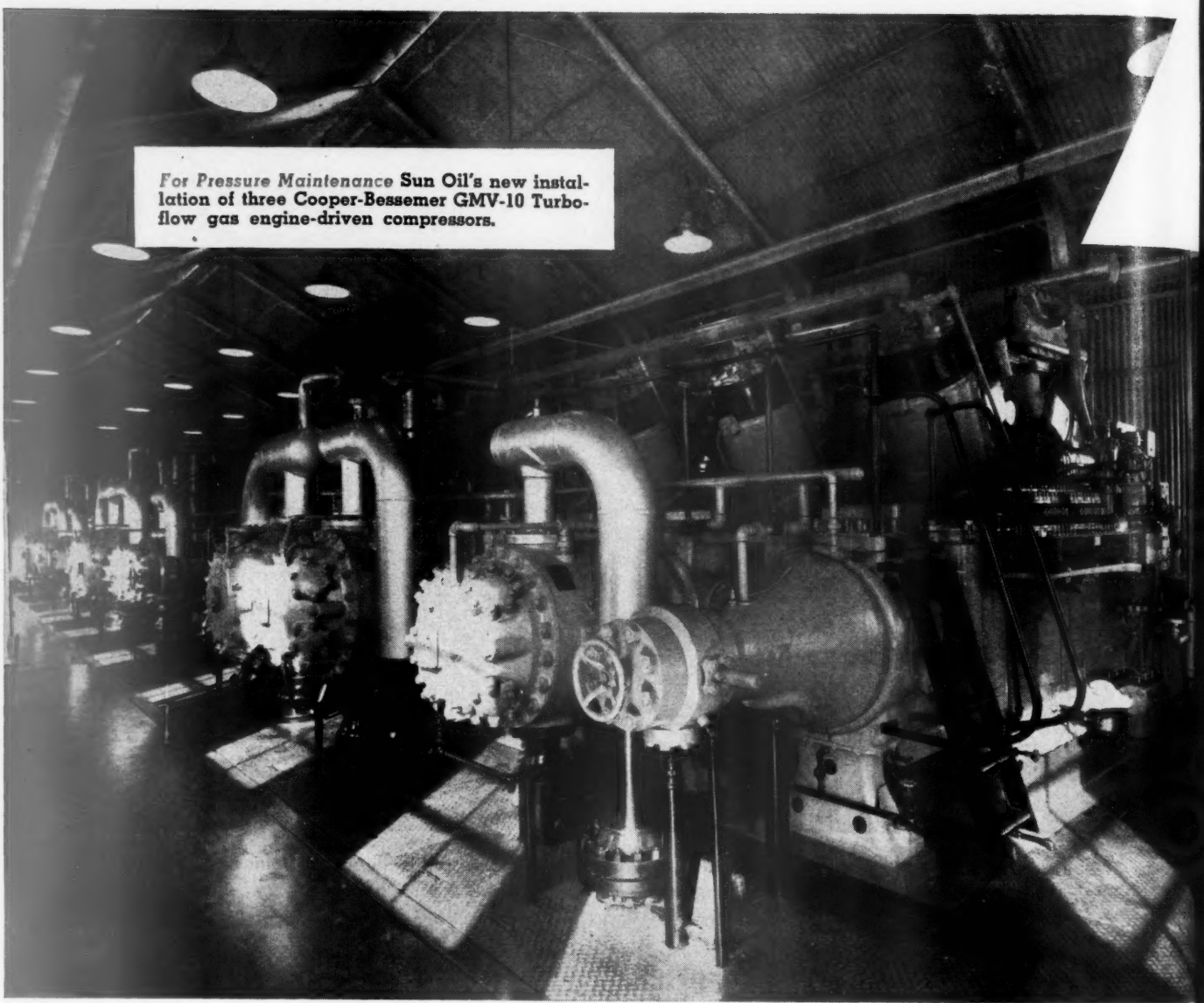
Abtsract

The need for synthetic liquid fuels in the United States arises from increased use of gasoline and oil for a great variety of industrial and domestic purposes coupled with increased difficulty and cost in finding petroleum. Raw materials available in abundant quantities for synthetic fuels are coal and oil shale, which are sufficient to meet all foreseeable demands for hundreds of years.

During the past decade great progress has been made in developing plants and processes for the production of synthetic fuels. New mining methods make possible the production of as much as 80 tons of oil shale per man day under ground. Three new retorts are under test that promise continuous low-cost methods of making oil from shale. In the Fischer-Tropsch process of converting coal to oil the required gasification methods now are available to produce synthesis gas in a single step from a wide variety of coals, either coking or non-coking. Fischer-Tropsch synthesis chambers now can be designed with capacities up to 1000 bbl per day of either a good motor gasoline or a good diesel oil. For the hydrogenation process cheaper methods of generating hydrogen have been developd which, coupled with the conservation of heat throughout the process, are expected to yield an over-all heat efficiency of about 45 to 50 per cent.

This progress, plus the increased cost of discovering and producing pe-

*Chief, Office of Synthetic Liquid Fuels, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.



For Pressure Maintenance **Sun Oil's new installation of three Cooper-Bessemer GMV-10 Turboflow gas engine-driven compressors.**

On the job

for the SUN OIL COMPANY

AT JAMESON FIELD, WEST TEXAS

Sun Oil's new field plant makes available about 8,000,000 cubic feet of high pressure gas for return to the oil producing horizon . . . and recovers up to 30,000 gallons of natural gasoline and butane-propane fractions daily.

Here, in this modern plant, Cooper-Bessemer units team up for highly

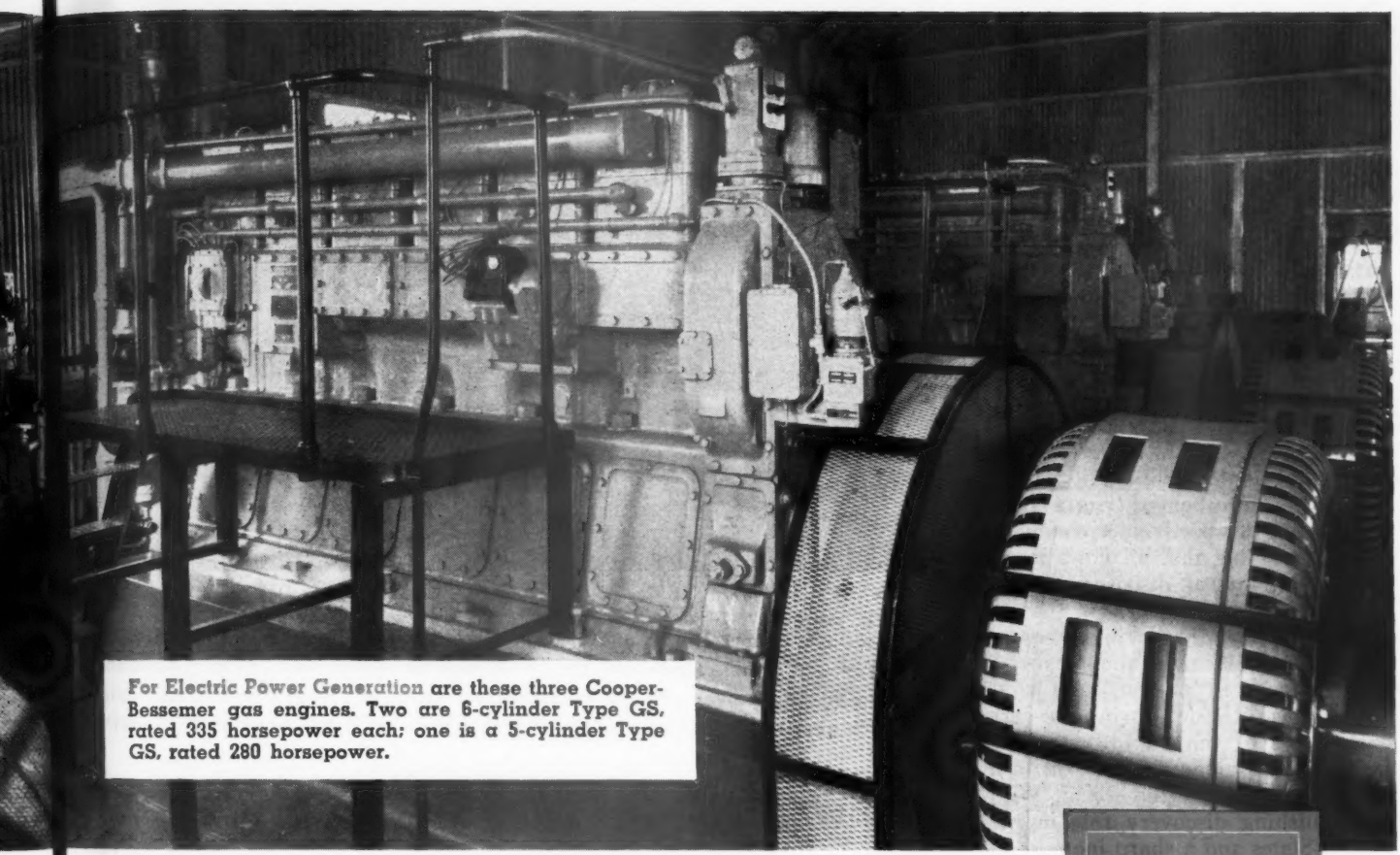
ANGLE

Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wa

PARTNERS PULL TOGETHER

For Dependable Low Cost Operation



For Electric Power Generation are these three Cooper-Bessemer gas engines. Two are 6-cylinder Type GS, rated 335 horsepower each; one is a 5-cylinder Type GS, rated 280 horsepower.

efficient performance — three 1,100 hp GMV Turboflow gas engine-driven compressors and three type GS gas engines driving generators.

The selection of Cooper-Bessemer Turboflow engines and compressors means a saving of up to 25% in space, in foundation, in cooling equipment and in fuel consumption compared with engines of equal displacement.

When your plans call for compressors or power for pumps or electric power generation, check first with Cooper-Bessemer. Remember there's a complete line of Cooper-Bessemer V-angle compressors — GMX, GMV, and GMW units ranging in size from 200 to 2500 horsepower.

Another Example of Efficient Power at Lower Cost

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

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troleum, has narrowed the price differential between synthetic products and those from petroleum. When coupled with considerations of national defense, these factors provide strong impetus for the development of a synthetic fuel industry in the United States.

THE dominant position of petroleum in the industrial economy of many nations has centered attention and effort on the provision of an adequate supply of this fuel. In virtually all cases, this has involved intensive exploration to discover oil not only within domestic borders but also in some foreign areas where the prospects were thought to be exceptionally good.

Since the start of this century when the automobile came into use, the consumption of petroleum has grown at an ever-increasing rate and world demand now is approaching 10,000,000 bbl a day. In spite of the great magnitude of this demand, it still can be met for a number of years from known and prospective petroleum reserves providing that oil flows freely from the point of discovery to the point of need.

The major oil-producing areas of the world are limited and localized, whereas the need for petroleum is essentially world-wide. During the very early days of the oil industry the United States alone supplied oil to a great proportion of the world. With a diminishing discovery rate in the United States and a sharp increase in demand, exportation of oil products in large quantities no longer is possible. Instead, the United States is becoming an importer of oil, particularly from the Caribbean area which is assuming increasing importance as a source of world oil supply. Fortunately, at this time of need, the apparently enormous reserves of oil in the Middle East are being developed to help meet the world requirements, particularly those of Europe.

In the past, one of the strong factors inducing the development of synthetic liquid fuels has been this limited geographical area of oil supply. Industrialized nations that did not have an adequate petroleum reserve within or close to their borders tried to develop processes that could supply liquid fuels from the raw materials they possessed. The oil shale industries in England, France, Sweden, Estonia, South Africa, and other countries evolved from this desire to have an indigenous oil supply. In Germany the same factor led to the development of a large industry making oil from coal.

—Bureau of Mines photo.

Large-scale equipment used underground keeps mining costs low at the experimental oil-shale mine operated by the Bureau of Mines near Rifle, Colorado. Here an electric shovel with a 3-cu-yd dipper loads a 15-ton diesel truck while holes for next round of shots are sunk by multiple drills mounted on truck, left.

Until the beginning of the last war, it is doubtful that fuels were manufactured synthetically as cheaply as oil could be supplied in any country, assuming the absence of specific taxes on oil and the need of a sufficient supply to justify economic transportation such as by pipeline or tanker. Development of synthetic fuel processes since the war indicates that in some cases synthetic fuels are about ready to compete with petroleum and its products on a price basis.

Synthetic Fuels in the United States

The economic well-being, security, and progress of the United States are linked directly to an adequate supply of oil. Here, there is roughly one automobile for every family. These, of course, are used for pleasure, but more often they take the family head to his daily work over distances that may exceed 10 or 20 miles. Public transportation cannot satisfy this need, particularly in areas of scattered suburban dwellings that are becoming increasingly popular. In addition, the shopping districts or other facilities that may be some distance from the family car makes it possible to reach home.

There has been a great increase in the use of oil for home heating. Obviously more convenient than a solid fuel, it eliminates the irksome task of hand shoveling coal and ashes.

The American farm is being mechanized with power from oil. Gasoline and diesel-driven machinery have become indispensable aids to food production. In 1800 three out of four individuals in the working population were required to provide food. Now only one in seven is needed, and a single farm worker supplies food for himself and 13 other people. Much of this improvement is directly attributable

Synthetic Fuels

More than 400 scientific papers were discussed at 60 section meetings of the United Nations Economic and Social Council conference. This paper discusses the need for synthetic fuel in the U. S.

Reboilers...all G-R

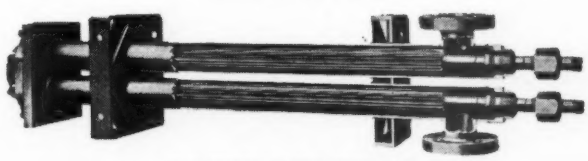
The El Paso Natural Gas Company has so many installations of G-R Heat Transfer apparatus that a complete list would be difficult to compile.

However, the accompanying photographs, taken at random at Jal, New Mexico, indicate the wide range of services for which the Company uses G-R apparatus. The illustrated G-R units include Twin G-Fin Section Primary Exchangers, Type FST Tubular Secondary Exchangers, a G-R Solution Reboiler, and Twin Bare Pipe Regeneration Gas Heaters.

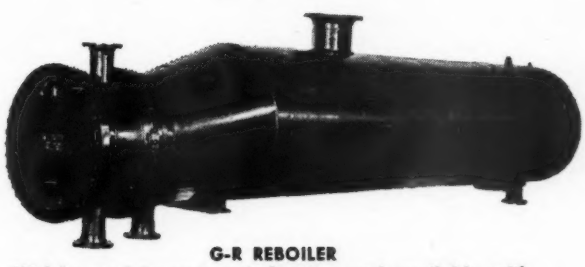
This company, like so many others throughout the oil and gas industry, has evidenced its satisfaction with G-R Heat Transfer Apparatus in the most unequivocal and convincing manner — by wide use and by repeat orders.

You, too, can be assured of satisfactory service from heat transfer apparatus by standardizing on G-R. When doing so, you get the benefit of the unequalled G-R experience, the extensive variety of G-R designs, and the long-proven merit of G-R apparatus. Whatever may be your heat transfer needs . . . condensing, cooling, heating or heat exchange . . . be sure to consult the G-R engineers for their authoritative advice.

G-R TUBULAR EXCHANGER
A shell-and-tube unit with many distinctive features for efficient performance with minimum attendance and maintenance expense.



G-R TWIN G-FIN SECTION
The "universal" standard interchangeable heat transfer unit with longitudinally-finned elements. More than 40,000 installed sections.



G-R REBOILER
Widely used in process industries, and available with either bare tubes or K-Fin helically finned elements.

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GRISCOM-RUSSELL

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to the use of machinery driven with oil and gasoline. The tractor, combine, cotton picker, and other large equipment are only a part of this story. Equally important are those much smaller machines that speed up and lighten the burden of the farm family's numerous daily chores. An oil-driven electric generator often provides light for the house and barn, power for the milking machines, cream separator, and water pump, and for all the labor-saving household equipment. In addition, the farmer can cut wood with a gasoline-driven saw or spray paint on his buildings with a gasoline-driven air compressor. While the oil-propelled revolution in farming during and since the last war has been extensive, it is far from complete—in fact, it is only beginning—and an increased fuel demand for such equipment is certain.

American railroads traditionally have used steam locomotives burning coal. Since 1940, however, there has been an increasingly rapid conversion to diesel engines, first for switching purposes in the yards and then for general use. Now 98 per cent of the new locomotives on order are of the diesel type, which indicates that before many years the entire land, air, and water transportation system of the United States will be based on oil.

Industrial applications of oil are growing as well. It serves for power generation, especially in the Southwest and West; it fires metallurgical furnaces; it drives ships; it supplies a large chemical industry; and it lubricates the machines of all industries.

From these and countless other applications, it may readily be seen not only that the economy of the United States is dependent upon oil but that this dependence is growing broader and greater. This country, therefore, must have assured oil supplies not for just a few years in the immediate future but for an indefinite period.

In contrast with this increasing demand, it has become more and more difficult to discover new oil in the United States. This situation has led to the active interest in synthetic fuels.

Raw Materials for Synthetic Fuels

The United States possesses three important raw materials from which oil can be made in quantity. There are natural gas, coal, and oil shale. It is interesting to compare briefly the potential oil available from these sources with the present known reserves of petroleum, which exceed 20 billion bbl. Known reserves of natural gas are estimated at 170 trillion cu ft, much of which is needed for pipe lines serving industrial or domestic users. It now appears that some 25 or 35 trillion cu ft could be dedicated to oil production which would amount to 2½ or 3 billion bbl. This estimate can be altered greatly by future demands for gas on one hand and future discoveries on the other. At this time it does not appear that there is enough uncommitted natural gas to make a major addition to oil reserves.

Coal reserves in the United States are estimated at 3 trillion tons, which is roughly half the known reserves of the world. However, this includes coal in seams down to 14 in. thick and at depths of 3000 ft. The thin seams at great depths certainly would not be considered minable for synthetic fuel purposes under present-day conditions. Nevertheless, the reserves are so great that supplies of minable coal are sufficient to meet all needs, including the production of the total oil demand from coal, for many hundreds of years. A relatively detailed survey of only a part of one coal producing state recently revealed suitable sites (including water and other facilities) for 60 synthetic fuels plants. Over their life these plants would produce about 25 billion bbl of oil. A similar survey will be conducted in the remainder of this state and in other coal producing states.

Reserves of oil shale are large, but are not yet well explored and they range widely in oil content. The largest and richest are in Colorado, Utah, and Wyoming, and the recoverable oil is estimated to be in excess of 200 billion bbl, or about 10 times the known petroleum reserves. Production of oil from this source will not be controlled by the magnitude of the reserves, but rather by the water available in the area for plant and community use. Information now available does not allow a prediction of the number of plants that might be operated to make oil from shale.

Synthetic Fuel Processes

Oil can be produced from natural gas, coal, and oil shale by one or more of three known processes—Fischer-Tropsch, coal hydrogenation, or retorting. Each has been investigated abroad and in the United States, and great progress has been made, particularly since the end of the war.

Fischer-Tropsch Process

In general the Fischer-Tropsch process as practiced commercially has involved: (1) coking bituminous coal, (2) production of water gas from the coke, including purification and adjustment of proportions for use as synthesis gas, (3) catalytic combination of the components of the synthesis gas to make hydrocarbons, and (4) separation of the products.

For the production of large amounts of liquid products this process had several serious faults. It required coking coals which are available only in limited areas and which often are costly to mine. Coke ovens and water gas machines are expensive to install and operate. The Fischer-Tropsch catalytic conversion chambers were small, usually producing only about 15 to 20 bbl of oil a day. A plant making 10,000 bbl of oil a day would need 500 or more converters. Servicing this large number of converters is not practical under American conditions. And finally, the yield of motor gasoline was relatively poor (25 per cent) and its octane number was low.

Many of these faults are now on the way to correction. Where natural gas is cheap it can be burned with oxygen and steam[2] to supply a low-cost synthesis gas. Carthage Hydrocol, Incorporated, is building a plant of about 7000 bbl a day capacity that will use natural gas in this manner at Brownsville, Texas. The oxygen will be obtained from air by liquification processes. Coal also can be burned directly with oxygen and steam to provide synthesis gas. The Bureau of Mines now is testing three separate experimental units designed to do this. Rated capacity varies from about 200 to 2000 lb of coal an hour. Test results indicate that almost any coal can be used with the possible exception of strongly coking coal. Reaction rates are high with large throughput for relatively small units of equipment. The steam used in the reaction is superheated as much as possible to decrease oxygen consumption. In continuous pebble heaters, steam can be heated to about 2600 to 2800 F. (1430 to 1540 C.) In intermittent heaters it is believed that temperatures up to 3800 F (2090 C) can be reached.

Three types of Fischer-Tropsch synthesis chambers have been developed with capacities of more than 500 bbl of primary product a day. The first of these uses a fluidized catalyst, and heat is removed by tubes carrying cooling water through the reaction space. Development work on this unit was carried out by several oil companies, and it is being installed in the Carthage Hydrocol plant in Texas.

The Bureau of Mines has developed one converter using a fixed bed

[2]Natural gas also can be cracked catalytically with steam to furnish synthesis gas.

catalyst, either pelleted or granulated. This catalyst is immersed in oil (a fraction of the product) to control the temperature. Synthesis gas is bubbled through the oil, and heat is removed by external heat exchangers. This unit has high capacity and can be used with either cobalt or iron catalysts.

A second converter unit is under development in which finely powdered catalyst is suspended in an oil bath, forming a slurry, through which the gas is blown. This unit offers excellent temperature control with high throughput. Heat is removed by circulating the slurry through an external heat exchanger, or by extending bayonets carrying cooling water into the reaction space.

The improvements in gasification and synthesis will have considerable effect in reducing both investment and operating costs in the Fischer-Tropsch synthesis.

Hydrogenation Process

A study of the thermal efficiency (ratio of heat in the incoming coal for all purposes to heat in the outgoing products) of some of the European hydrogenation plants indicates an overall efficiency of about 30 per cent. If a major improvement in this figure can be obtained it would lower both plant investment and plant operating costs.

The hydrogenation operations are essentially as follows:

1. Coal preparation and paste making.
2. Hydrogen production and compression.
3. Liquid phase conversion.
4. Vapor phase conversion.
5. Separation of the products.

Step 2, hydrogen production and compression, accounts for about 50 per cent of the operating cost and at the same time offers material opportunities for increased plant efficiencies. The major proportion of the required hydrogen can be made by cracking the non-liquefiable hydrocarbon gases produced in the process and making up any further needs by the direct gasification of coal with oxygen. This avoids the wasteful burning of hydrocarbon gases and eliminates installation of large coke oven and water gas machines.

Substantial improvements can be made in the liquid and vapor phase conversions by more effective use of the exothermic heat of the hydrogenation reactions; full heat exchange between the outgoing hot gaseous and liquid products and the incoming cold paste; and finally by letting down the very high pressures through power recovery units.

By taking full advantage of all available methods of saving heat it is estimated that a thermal efficiency of nearly 55 per cent can be obtained, compared with an actual efficiency of about 30 per cent in Germany. In practical application an efficiency of 45 to 50 per cent is probably the best that can be expected at present.

The Bureau of Mines now is operating a hydrogenation demonstration plant in the State of Missouri to test means for attaining the improvements that have been outlined. This plant will produce about 200 bbl of oil or gasoline a day and has been in operation since the early part of 1949. Significant results will be available about the end of this year.

The approach which has been described for improvement of the hydrogenation processes is largely an engineering attempt to carry out a certain chemical process more efficiently. It is equally necessary to consider major process modifications.

One of the more promising of these on which the Bureau of Mines has done a great deal of development work is the dry hydrogenation of coal. Hydrogen and dry coal are fed directly to a converter where they react to produce gaseous, liquid, and solid hydrocarbons. This eliminates paste making, paste pumping and preheating and, under some conditions greatly decreases the amount of hydrogen needed. This process, however, is in only a laboratory stage.

Shale Oil

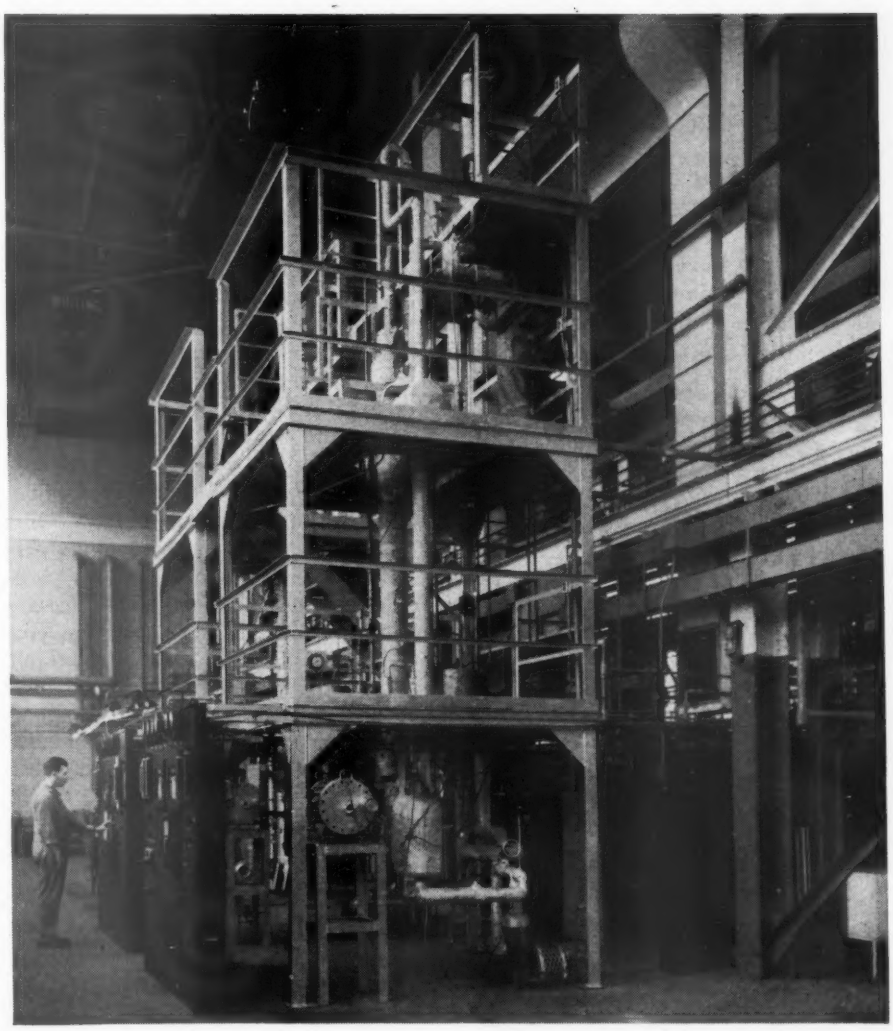
Producing oil from shale involves the following major steps:

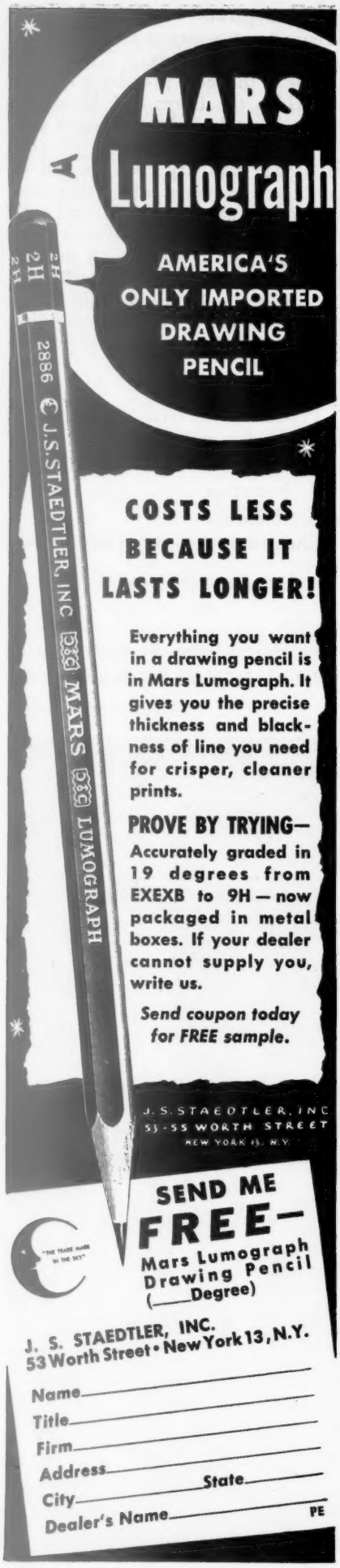
1. Mining.
2. Retorting.
3. Refining.

Situated in Colorado, most of the

Gas synthesis (modified Fischer-Tropsch) pilot plants, internally cooled by oil circulation, Bureau of Mines synthetic liquid fuels laboratories, Bruceton, Pa.

—Bureau of Mines photo.

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richest shale beds are about 500 ft under ground, and strip mining is possible only in very limited areas. In general, the shale outcrops and drift mining is practical. Mining can be carried out in a 70-ft section that will average 30 gal of oil per ton. Under present conditions oil from shale might be worth $2.50 a barrel. As 1½ tons of shale are required to produce a barrel of oil, it is apparent that mining costs must be low to make the use of oil shale at all attractive.

At the Oil Shale Demonstration Plant operated by the Bureau of Mines near Rifle, Colorado, mining methods and equipment have been developed to assure low-cost production. A room and pillar system of mining is used, and no roof support is needed in rooms as wide as 60 ft. The 70-ft section is mined in 3 benches of about equal height. In the first bench, horizontal drilling is required to open the rooms, but the next two benches then can be drilled vertically. A multiple drill has been developed that drills four horizontal holes simultaneously. Average drilling rate is about 90 ft of 2-in. hold per man hour. Special research finally has culminated in a hard-surfaced bit that will drill from 100 to 200 ft of shale before it is dull. Holes now are drilled to a depth of 10 ft, but this depth may be increased to 15 ft. Approximately one ton of shale is obtained for each foot of drilling. Powder consumption is less than ½-lb per ton of shale.

Large diesel trucks are driven directly into the mine and loaded with shale by an electric shovel having a 3-yard dipper. This shovel, operated by a single man, can load as high as 300 tons of shale an hour.

Operation of the demonstration mine has shown that production rates as high as 80 tons per man day (underground workers) can be achieved. Total cost for mining shale is estimated at 60 cents per ton.

Under American conditions, with high labor costs and the need for very large commercial plants, it is probable that the only successful retorting methods will be those that are continuous and have high throughput. Although hundreds of methods have been suggested and used for retorting shale, three now under test appear to offer the greatest promise for meeting these conditions. These are the gas flow retort of the Bureau of Mines, the fluid flow retort of Standard Oil Development Company, and an internally-fired underfeed retort developed by the Union Oil Company of California.

In the gas flow retort shale passes downward and hot gases flow across the retort. Operation is continuous and the throughput is high. Heat for operation is obtained by burning waste gas and spent shale in a space separated from the retorting area. This unit is being tested by the Bureau at Rifle, Colorado.

Fluid Flow Unit

The fluid flow unit consists of two vessels, one for retorting the shale and the other for burning the spent shale. Hot spent shale is blown from the combustion zone to the retorting zone to provide heat to drive the oil from the raw shale. This process now is being tested on a pilot plant scale by the Standard Oil Development Company at Baton Rouge, Louisiana. The Bureau of Mines is supplying the shale and co-operating in conducting these tests.

The retort developed by the Union Oil Company forces a column of shale upward through a vertical cylinder by means of piston arrangement at the bottom. Spent shale is burned in the upper part of the retort, and the hot gases flow downward to remove the oil from the raw shale. The retort is high enough to use the incoming shale to condense partially the oil from the outgoing vapors. In addition to high throughput and continuous operation, this retort also offers the advantage of relatively low water consumption. This is important in the arid regions in which the best American shales are located. It now is undergoing preliminary tests in California and then will be set up at Rifle, Colorado, for continuous operation.

From the test programme on these three types of retorts, it is believed that one or more will be found suitable for economical retorting of American shales.

American Shale Product

Crude oil from American shale runs from about 18 to 25 A.P.I. gravity depending on the method of retorting and recovery of light ends. Its character is different from petroleum and many foreign shale oils. It is generally asphaltic and contains a considerable amount of nitrogen compounds which occur rarely in petroleum. Sulphur content is about 1 per cent and nitrogen about 2 per cent. On distillation it yields about 5-10 per cent of low octane gasoline, 15-20 per cent heating oil, about 25 per cent gas oil, and the remainder residual oil. The gasoline yield can be increased by cracking, but it still has a low octane value and there is a considerable loss of oil through coke formation. Extensive research now is in progress both in industrial laboratories and in the

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Bureau of Mines to develop improved methods for refining shale oil.

Plants for the Production of Synthetic Fuels

Plants for the production of synthetic fuels from coal would cost more now than equivalent capacity in oil wells and refineries. This differential is rapidly narrowing, however, as further improvements are made in synthetic fuels processes and as the costs of finding and developing new petroleum advance. On the other hand, shale oil plants are less expensive.

A recent estimate from industry shows that the capital investment required for each barrel day of new petroleum capacity is about $5000 to $6000, including expenditures for exploration, field development, transportation and refining.

Comparable estimates for synthetics, based on a detailed analysis by the Bureau of Mines in the early part of 1948, are $3100 per barrel day for shale oil, $5300 for synthetic oil from natural gas, $8600 for synthetic oil from coal using the gas synthesis or modified Fischer-Tropsch process, and $9000 for synthetic oil produced by direct coal hydrogenation. These estimates include the investment required for coal and shale mining.

Moreover, the steel requirements for synthetic fuels plants — long thought to be excessive—under some conditions may actually be less than those for an equivalent new capacity of petroleum. This may be attributed to a sharp increase in the quantity of steel needed for drilling wells. A far greater percentage of dry holes are being sunk than in former years, and deeper holes are required to reach the oil when it is present.

Including drilling operations, pipe lines to refineries, and the refineries themselves, 6 tons of steel now are required for each barrel day of new petroleum capacity. On the other hand, steel requirements for oil shale plants would average 3.5 tons, for synthetic plants using natural gas 4.7 tons, for gas synthesis plants using coal 6.6 tons, and for coal hydrogenation plants 6.4 tons per barrel day of new capacity. Once synthetic fuel plants were built, no additional steel would be required other than for maintenance and normal equipment replacement for some 20 to 25 years—the life of the plant.

Table 1 presents the material and manpower requirements and the salient cost figures for a hypothetical industry adequate to produce 2 million barrels a day of synthetic fuel products. For convenience, it also shows the amount of products from

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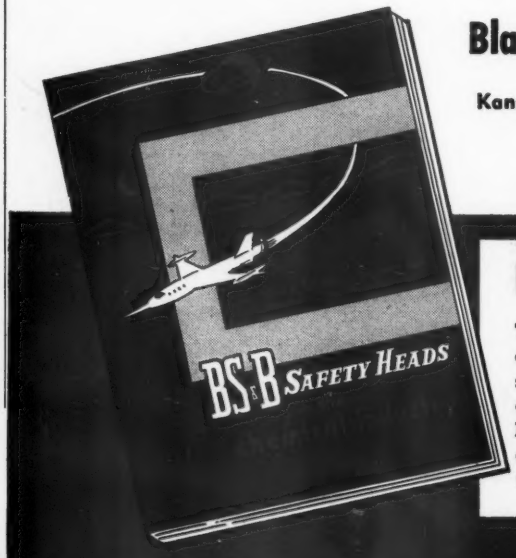

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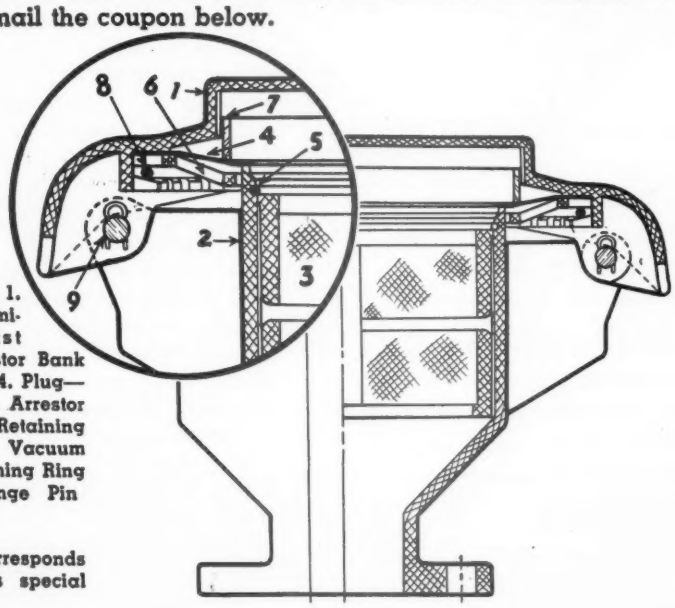

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4	2.5	16	0.5
6	2.5	16	0.5
8	2.0	16	0.5
10	2.0	16	0.5
12	2.0	10	0.5
16	2.0	8	0.5
20	2.0	6	0.5
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TABLE 1. Summary of requirements for a 2-million-barrel-a-day synthetic liquid fuels industry geared to peacetime fuel demands but readily convertible to military products in event of emergency.

Process	Raw material tons or cubic feet per day	Capital investment dollars	Capital investment $ per barrel per day	Steel tons	Steel tons per barrel per day	Operating force	Products, barrels per day			Total products barrels per day	Cost cents per ga of total prod
							Gasoline Petroleum gases	Distillate	Fuel oil		
Oil shale	1,500,000	2,600,000,000	3,100	3,000,000	3.5	60,000	116,000	215,000	519,000	850,000	5.5
Fischer-Tropsch											
Natural gas	1,600,000,000	800,000,000	5,300	700,000	4.7	7,500	133,000	17,000	.....	150,000	7.2
Coal	350,000	4,300,000,000	8,600	3,300,000	6.6	60,000	441,000	59,000	.....	500,000	12.1
Coal hydrogenation	250,000	4,500,000,000	9,000	3,200,000	6.4	68,000	293,000	207,000	.....	500,000	12.6
Total	.....	12,200,000,000	.....	10,200,000	....	195,500	.....	.....	.....	2,000,000	....

each source material and the average cost per gallon of total synthetic liquid fuel product. The capital investment required under conditions existing during the first half of 1948 was about 12 billion dollars, the steel requirements 10 million tons, and the total operating force nearly 200,000 men. The estimated average cost of the full range of products, which includes fuel oil and gasoline, is 9 cents per gallon. This figure includes all costs except interest on investment and profit.

Conclusions

I have tried to indicate briefly the work that is going on and the progress that has been made in the United States in the development of synthetic liquid fuels. The effort by both Government and industry is of considerable magnitude, but the problem of meeting increased oil requirements to insure economic and military security is being thrust upon the country at a much faster rate than was anticipated in 1944 and 1945 when the present programmes were planned.

Fortunately, owing largely to process improvements, the cost factors upon which any large-scale synthetic fuel production will depend are becoming increasingly favorable in the United States. However, the improved relative cost position of the synthetic products also is attributable in part to sharply increasing costs of finding new petroleum. If this trend continues, it is probable that a large synthetic fuel industry based on coal and oil shale will develop in the United States. Known reserves of these raw materials are so large that they can meet all our needs for centuries—a comforting and reassuring fact. But it is well to remember that we still have far to go, not only in research and development but in plant construction as well, before liquid products are available in quantity from coal and oil shale to fuel the engines of America.

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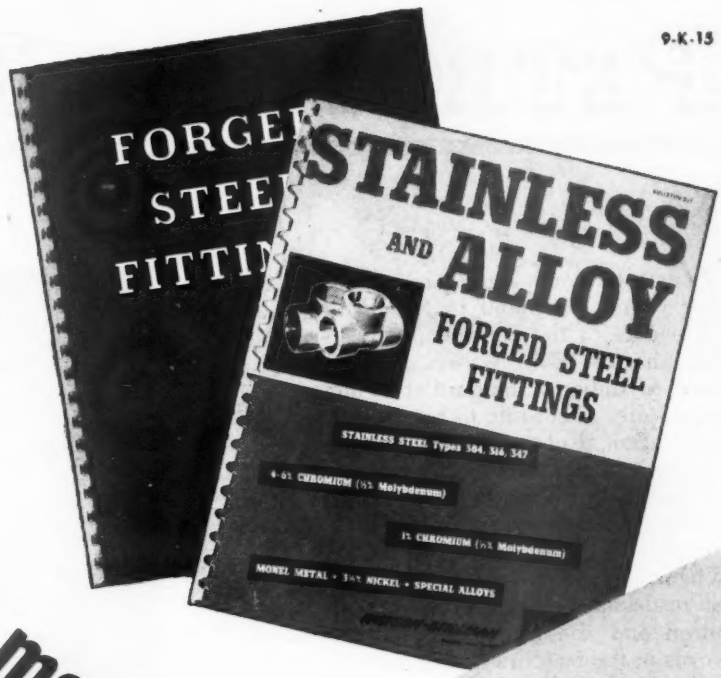
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PETROLEUM PROFILE

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Standard Oil Company (Indiana)

WITHOUT doubt a more colorful career cannot be found in the history of leaders of the petroleum industry than that of "Bob" Wilson, executive head of Indiana Standard's far-flung oil empire. According to biographer's delineation, Robert Wilson first saw the light of a probably murky, coal-smoke-shadowed day in Beaver Falls, Pennsylvania, over the hill from Pittsburgh's already smoggy valleys. Whether or not the legend of his childish restlessness is true, his lifelong ambition and ceaseless energy are bywords in the fraternity of oil men.

Sent to the College of Wooster, Ohio, he was graduated in 1914 with magna cum laude honors when he was barely old enough to vote the Republican ticket. In those days, as war clouds rained destruction on Europe, Massachusetts Institute of Technology was the pioneer in the newly developing chemical engineering field, and thither went Bob Wilson for two years of graduate chemical engineering work; interrupted by service during the American participation in World War I, he served as captain and major in chemical warfare service. Swapping the sword for the test tube, in 1919 he went back to MIT to direct the research laboratory of applied chemistry. An associate professorship in chemical engineering was the next milestone in his path.

Within the span of the current century at least, Indiana Standard's top executives have been singularly far-sighted in their attitude toward applied science and toward scientifically trained men. Already in 1922 the world-famous Doctor Burton, pioneer and father of hydrocarbon cracking technology and history, had broken trail into the region of refining, which was to revolutionize that industry completely. He and his colleagues were looking for scientifically trained talent possessing a self-starter. They went to MIT and hired Wilson as assistant director of research for one of the earliest organizations developed for the purpose in the American oil industry. General opinion and memory says that Wilson's first real job at Whiting was to establish and build and operate a dynamometer laboratory for testing oils and fuels for internal combustion engines. It would be interesting, indeed, to know his inner reactions at the occasion of the dedication of the new Indiana research plant last year.

Passing rapidly through the stages of assistant to the vice-president, chief of the patent and development department, director, and vice president of Standard Oil Company of Indiana, Wilson was made vice-chairman of its subsidiary, Pan-American, in 1935, and its president in 1937. While in that capacity the war clouds again gathered, and he was appointed head of the petroleum section of the Advisory Commission to the Council of National Defense, a body that later became the Office of Petroleum Administration, and the wartime Petroleum Administration for War. Before that situation developed, Wilson was called back to Chicago as president of Standard, to direct its energies in helping to win the war. He later became chairman of the board, his present position.

Wilson is a member of Phi Beta Kappa, and has been one of the top leaders in the American Chemical Society, American Petroleum Institute, and numerous other important technical and scientific bodies.

If "country boy" is defined as "scientist-technologist," and "big city" is synonymous with "great industrial executive," Bob Wilson is certainly an outstanding example of the country boy who made good in the big city.

Vocational Education Expands

As oilfield drilling and production operations become more complicated with deeper wells and more expensive machinery and equipment, the need for highly trained workers has become more pressing. This need is being met by the establishment of many new and specialized courses of instruction in local schools, junior colleges, and universities throughout the United States. Operators, contractors, professional societies, trade associations, equipment and service companies, local and federal government agencies, and private schools and institutions are sponsoring both general and specialized educational programs for the benefit of petroleum industry employees, prospective employees, and employers alike.

The expansion of such educational opportunities has been sponsored by employers and those who realize the need for more proficient and specialized workers. A great deal of time and money is being spent by the sponsors to provide the textbooks, meeting places, and instructors for these special courses. Many workers are paid while attending these schools. Others are paid expenses to enroll for instruction in their spare time. Still others are interested sufficiently in their own futures to obtain the textbooks, course outlines, and other material available for study and reference.

Many regular short courses, clinics, meetings, and vocational conferences are held for the purpose of keeping workers, including administrators, managers, engineers, geologists, technicians, and others, up-to-date on the latest methods, equipment, and tools developed for petroleum exploration, drilling, and production. Many companies are sending promising young managers back to school for an intensive course in the principles of business management. Harvard University offers such a course.

The AAODC is sponsoring management institute schools, drilling engine and equipment schools, drilling mud schools, safety clinics, and courses in drilling practices. The API holds regular meetings concerned with the standardization of drilling and producing equipment. Papers are presented at such meetings by leading technologists of the industry. Schools are conducted in many oilfield centers on such subjects as oil-treating, etc. (see page B-52 of this issue). The AIME, ASME, AAPG, AGA, and many others sponsor meetings, schools, and study groups for the education of workers in the industry. The calendar is filled with opportunities for one to learn and improve.

K Marshall Fagin

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If you have ever tried to run a swab and had the rubber cups so badly torn and damaged that they were useless – if you have ever hit a spot through which a packer or cement retainer would *not* run and had the slips set prematurely – you already *know* that the inside walls of casing should be scraped clean.

There is no longer need to have imbedded bullets, burrs from gun-shot holes, a hardened cement sheath, or any other obstructions, cause you trouble. Anything that projects from, or adheres to the important "working surface" of casing – even down to mill scale or rotary mud – can be quickly, easily, safely and economically removed from the inside wall of the casing. And this vital work of scraping can be done either while the rotary rig still is up and you are drilling out the cement shoe; or at any convenient time by running the scraper on tubing or a wire line for vertical removal of obstructions.

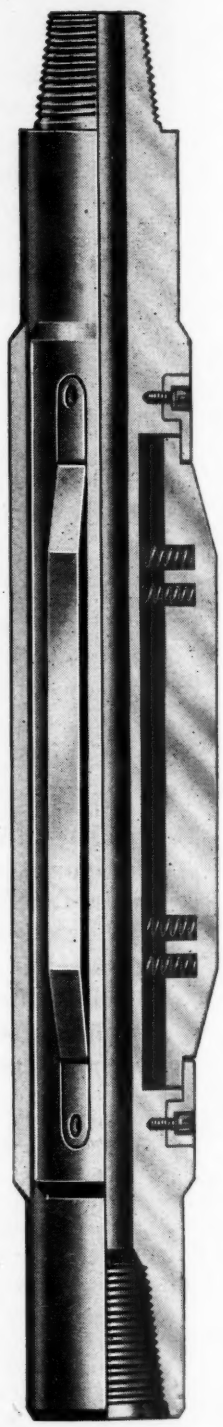
TWO TYPES OF BAKER CASING SCRAPERS MEET EVERY REQUIREMENT

The field-tested Baker MODEL "B" Casing Scraper (Product No. 620-B) is recommended for use when the rotary rig still is up and only hardened cement or a limited number of gun-shot burrs are to be removed. It is usually run just above the bit while drilling out cement, and will remove protruding burrs as well as the thin sheath of cement left even after the maximum gauge bit has been used for drilling out.

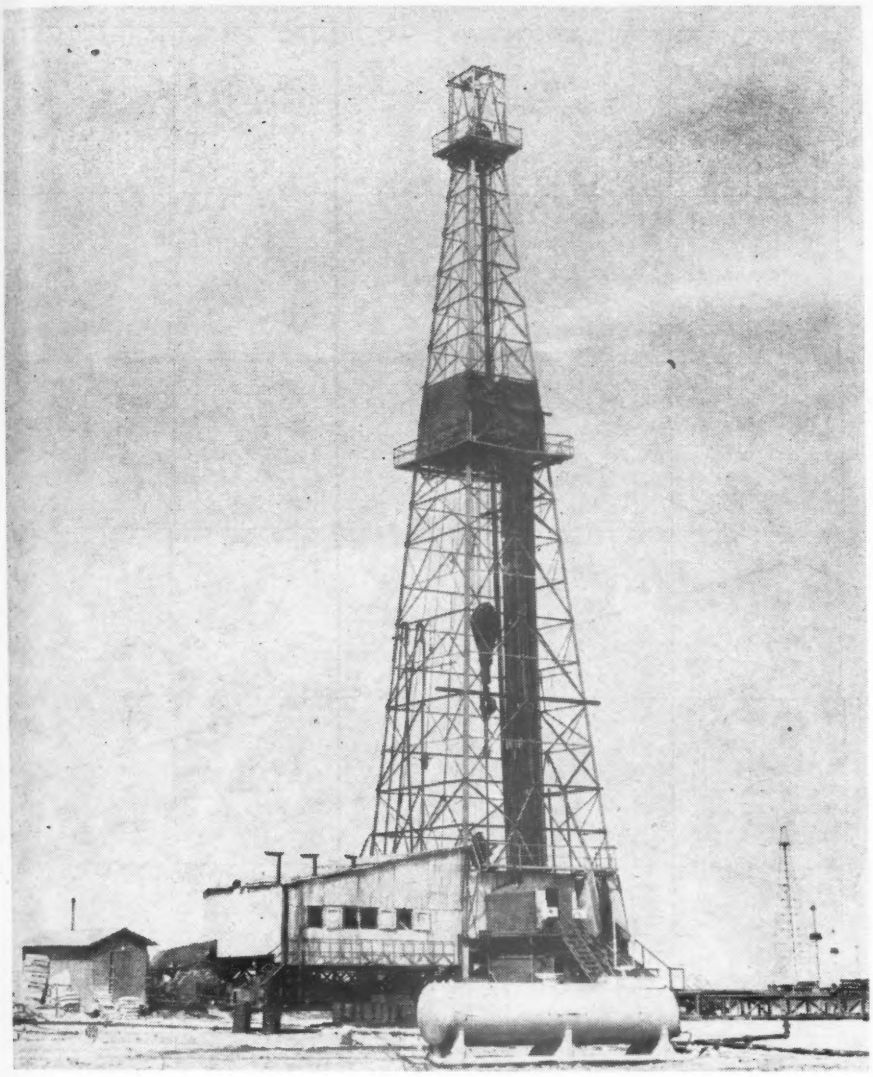
When there are several hundred gun-shot holes (with possible imbedded bullets); or if the hardened sheath of mud is to be removed from top to bottom of the well, the new Baker ROTO-VERT Casing Scraper (Product No. 620-C) is recommended. The ROTO-VERT can be run on drill pipe for successful vertical scraping of obstructions as it is being lowered in the hole, followed by rotation if difficult well conditions make rotation necessary or desirable; or it is run on tubing or a wire line for successful all-vertical scraping.

SCRAPING IS A VITAL PART OF WELL COMPLETION

Many operators consider that the use of a Baker Casing Scraper is a "must" in the completion of *every* new well, and after *every* gun-perforating job. They *know* that the inside wall of the casing is left smooth and "clean as a hound's tooth" ready to run a swab or testing



Baker MODEL "B" Casing Scraper
Product No. 620-B



Drilling rig on Magnolia's Roy Glass No. 2—Section 36. Derricks on other wells in the Pegasus field appear in the lower right hand corner.

13,000-Ft Pegasus Area

Development and Economics of Two Deep Fields in Upton and Midland Counties, Texas—Biggest Discovery in 1949

K. MARSHALL FAGIN*

MORE than 20 rigs are now operating in the new Pegasus and Sweetie Peck fields of Upton and Midland Counties, Texas. Magnolia Petroleum Company's T.X.L. "A" well No. 1, the discovery well in the Pegasus Ellenburger field, was completed on February 20, 1949. Its initial production of 1167 bbl of 53-deg API crude oil through a ¾-in. positive choke from perforations in the Ellenburger lime between 12,700 and 12,760 ft opened the biggest West Texas discovery of 1949 and one of the world's deepest oil fields.

General American Oil Company's Jose Fay Peck well No. 1, the discovery well of the Sweetie Peck Ellenburger field (about 5 miles west northwest of the Pegasus discovery well), was completed on February 28, 1950. This well flowed 1056 bbl of 53-deg API oil through a 1-in. choke from perforations in the Ellenburger between 13,128 and 13,250 ft. It opened what now appears to be another separate major field in the deep Midland basin of West Texas—and possibly the most important discovery of 1950 in that area.

Although the Pegasus and Sweetie Peck fields now appear to be situated on separate structures, the distance between them is not great. Future development of the various producing formations may bring them closer together. The Pennsylvanian and Devonian formations have oil and gas producing possibilities in both fields as indicated by favorable drillstem tests.

The Wolfcamp formation of Lower Permian age had a favorable showing while drilling and is now being tested for oil and gas production in the Lewis Lohman Peck No. 1, the West offset to the Peck No. 1 discovery well. It is reported to have flowed 9 bbl of condensate per hr on a ¼-in. choke with a ratio of 10,000 cu ft per bbl.

Completion Data

The Ellenburger formation in Magnolia's T.X.L. "A" No. 1 was topped at 12,520 ft, or—9630 ft subsea, and drilled to a total depth of 13,295 ft, where salt water was recovered on a drillstem test. Seven-inch casing had been set at 13,087 ft with 985 sacks of cement before the hole was carried to total depth. The well was plugged back to 13,195 ft after showing water at 13,295 ft. The open hole below the pipe was then acidized with 250 gal of mud acid and 3000 gal of 20 per cent acid without results.

After setting a retainer at 12,825 ft and squeeze cementing, the plug was drilled out. A leak was found in the casing at 12,088 ft. Several more squeeze jobs were performed to repair it before the casing was perforated for production from 12,700 to 12,760 ft with 6 jet shots. The well was then acidized with 1000 gal of mud acid and was brought in without swabbing.

The Ellenburger formation in General American's Peck No. 1 was topped at 13,128 ft, or—10,226 ft subsea, which was about 596 ft lower than the top of the Ellenburger in the Pegasus discovery well. The well was drilled to 13,338 ft, and 5½-in. casing was run and cemented at 13,336 ft with 100 sacks. Top of the cement was

*Editor, Exploration, Drilling and Production.

EXCLUSIVE

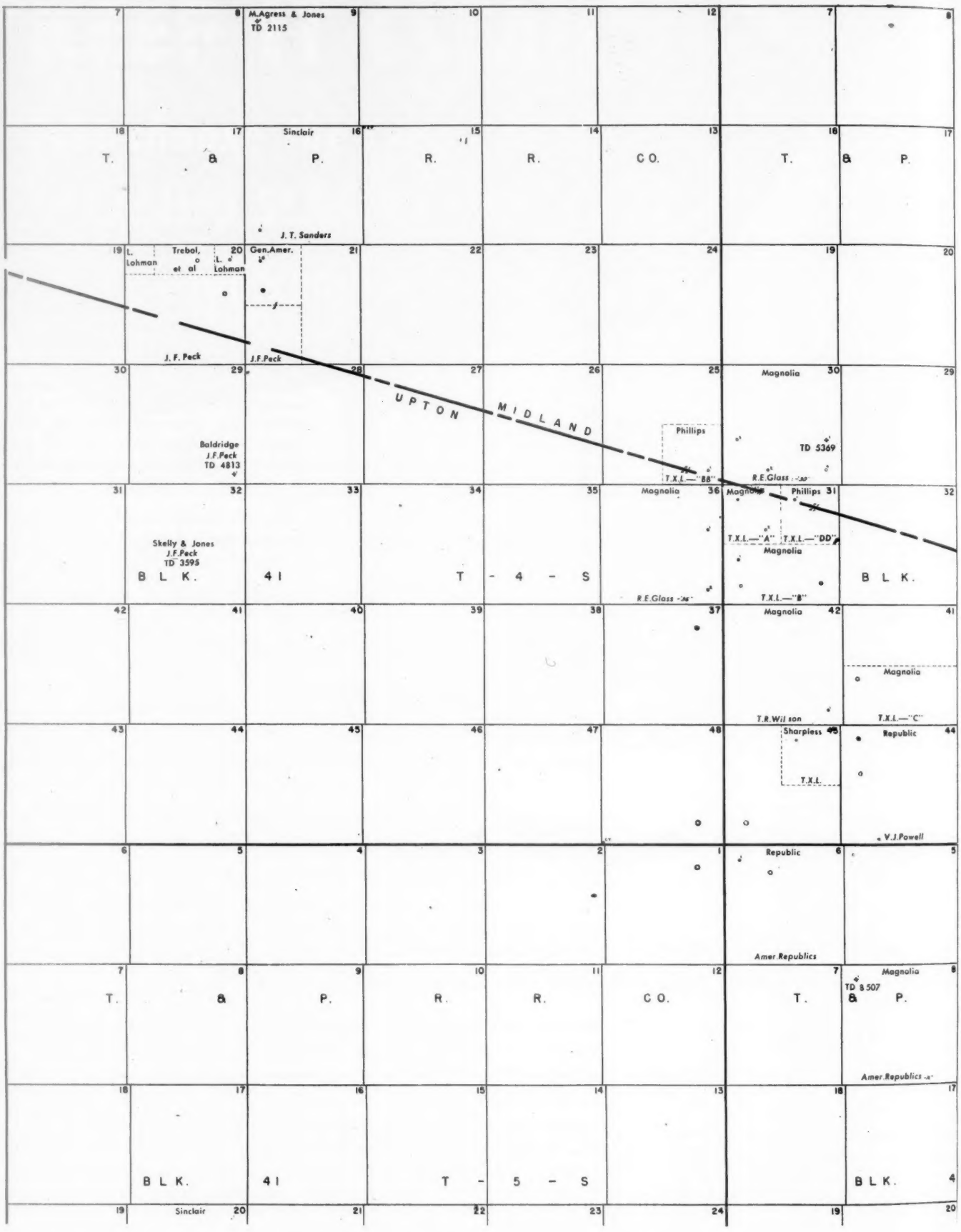


FIG. 1. The Sweetie Peck (Meadows) field (upper left) and the Pegasus field (right) of Midland and Upton Counties, Texas. More than 20 drilling rigs are now operating in these two fields. Lewis Lohman's Peck No. 1 (NENE of Sec. 20) may become the first dual completion and the first to produce from the Wolfcamp and Pennsylvanian formations. All eight completions so far have been in the 13,000-ft Ellenburger lime.

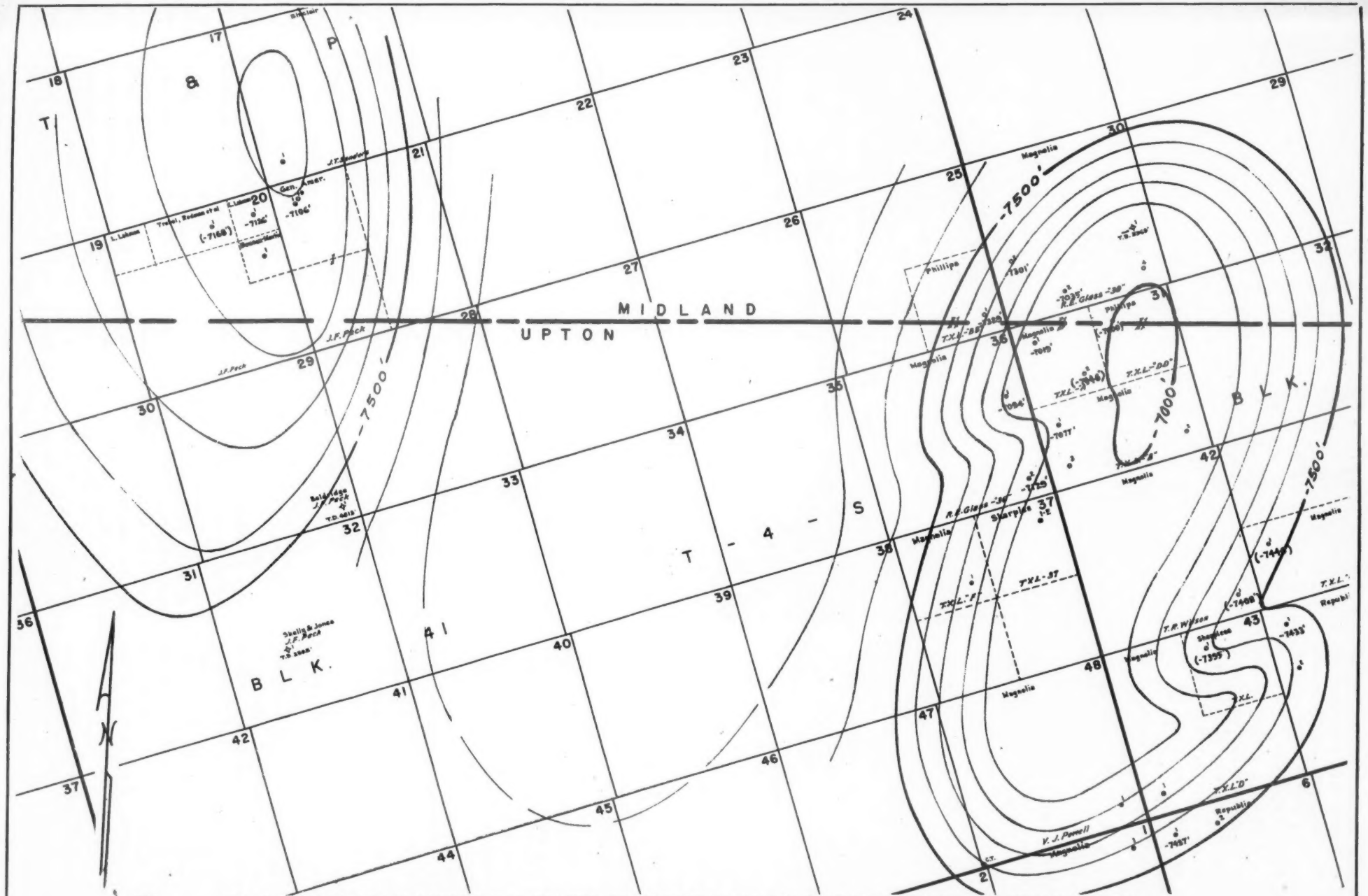


FIG. 2. SUBSURFACE STRUCTURE MAP ON TOP OF PENNSYLVANIAN IN SWEETIE PECK (left) AND PEGASUS (right). More than 400 ft of closure has been indicated by drilling so far in the Pegasus field. Contour interval = 100 ft.

found with temperature survey at 10,480 ft. Casing was perforated at 10,470 ft and squeezed with 150 sacks of cement. The well was then drilled to total depth of 13,399 ft.

After a drillstem test from 13,304 to 13,399 ft showed sulfur water with oil and gas, the well was plugged back with 150 sacks of cement to 13,313 ft. Casing was then gun-perforated for production with 488 shots from 13,128 to 13,246 ft. The well was then acidized with 1000 gal of mud acid and completed for the initial production shown above.

Ellenburger Thickness

The Ellenburger lime is 770 ft thick above the indicated water level of about 10,400 ft in the Pegasus discovery well. Phillips Petroleum Company's T.X.L. "B-B" No. 1, northwest offset to the discovery well, penetrated the Ellenburger about 200 ft. deeper, however, before definitely obtaining bottom water. This well is now testing for completion at plugged back depths.

The Pegasus discovery well is the highest well drilled so far in the area on the top of the pre-Pennsylvanian formations. It was about 19 ft lower on the top of the Pennsylvanian, however, than the Phillips' T.X.L. "D-D" No. 1, which is about a half mile east. The lowest well drilled so far in the Pegasus field is the Republic Natural Gas Company's American Republics No. 1, which is about 3 miles south of the discovery well. It was about 530 ft lower on the top of the Ellenburger.

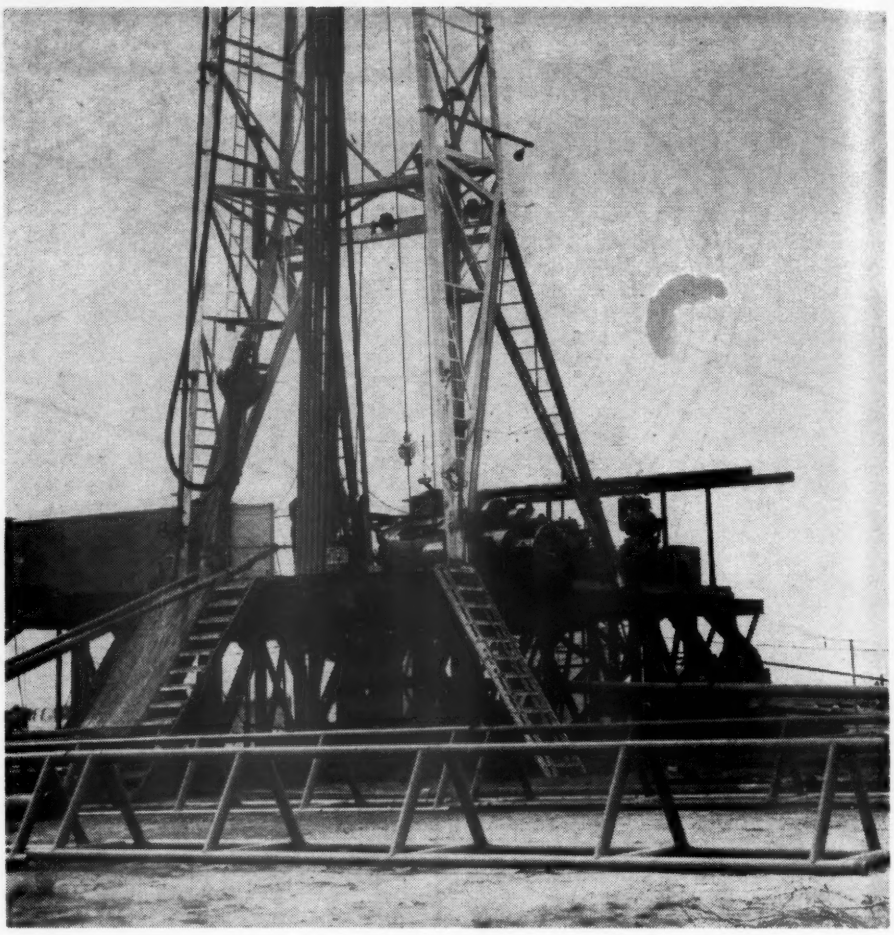
Thickness of Pay

No cores have yet been taken in any of the Ellenburger wells in the two fields. The net effective porosity in the thick Ellenburger section is a matter of speculation, therefore, from drillstem tests of the various wells and from drilling time records. About 240 ft of the Ellenburger in the discovery well appeared to contain some effective porosity. More of the section might respond to additional acid treatment, etc.

General American's discovery well in the Peck field penetrated the Ellenburger about 270 ft before recovering water on a drillstem test. The top of that test indicates that the water level is about—10,400 ft, the same as indicated in the Pegasus discovery well. This would leave the Peck discovery well with about 170 ft of Ellenburger section above water. It is now producing from the upper 118 ft of the section.

Pennsylvanian Prospects

The Pennsylvanian lime is expected to produce from 75 to 100 ft of section tested favorably in several wells. This lime is identified as Strawn. Effective porosity was topped about 10,095 ft in the Pegasus discovery well, or—7205 ft, which is nearly 200 ft below the top shown on the accompanying geological structure map. The closure on this formation in Pegasus is more than 500 ft, and no water has been found in it so far.



Some diamond cores have been taken in the Pennsylvanian in Pegasus, and it has flowed oil and gas on drill stem tests in both fields. Although it drilled hard and was without shows in the Republic well, it might produce oil in that area after acidization. None of the wells drilled so far have attempted to complete in the Pennsylvanian, but it may produce over a wide area when the operators begin to develop it.

Devonian Prospects

The Devonian formation was topped at 11,130 ft in the Pegasus discovery well, or—8240 ft subsea. The lower 200 ft of this 700-ft thick dolomitic limestone with chert streaks showed oil and gas on drillstem tests and is expected to produce when developed. The Peck discovery well topped the Devonian at 11,555 ft, or—8653 ft subsea, which is about 413 ft lower than in the Pegasus well. A 2-hr drillstem test from 12,175 to 12,325 ft flowed oil at an estimated rate of 20 to 30 bbl per hr. Two other drillstem tests above 12,175 ft indicated other oil and gas producing possibilities in the Devonian in Sweetie Peck.

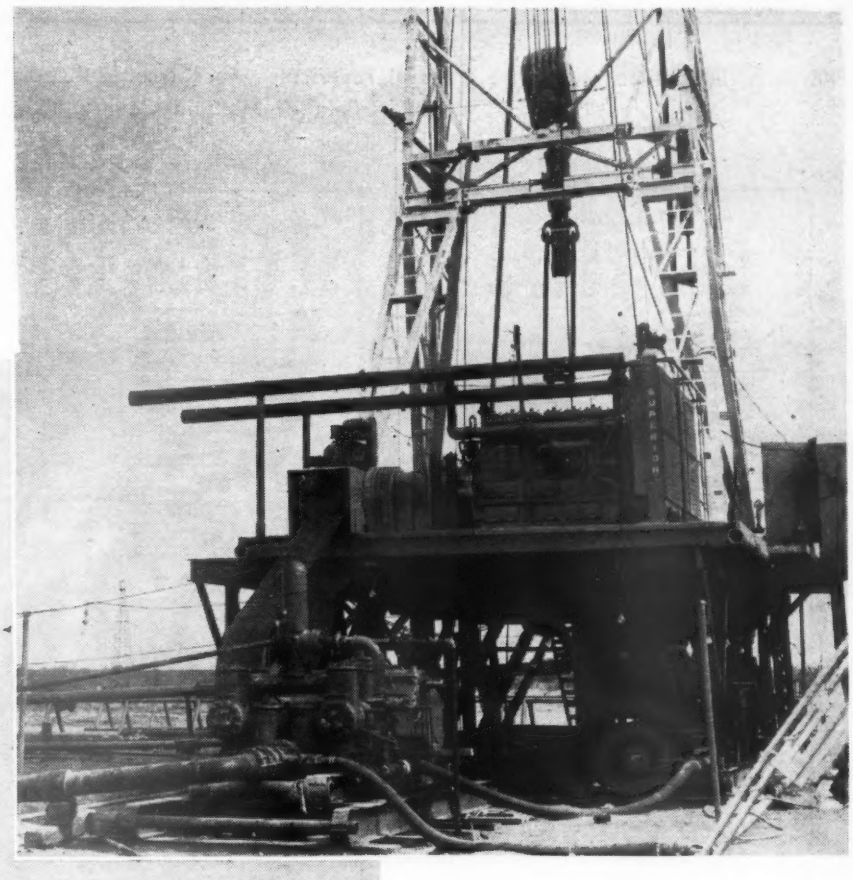
The Fusselman formation of lower Silurian age has shown some promise of oil and gas production in both fields on drillstem tests. About 100 ft of the section may respond favorably to acid treatment.

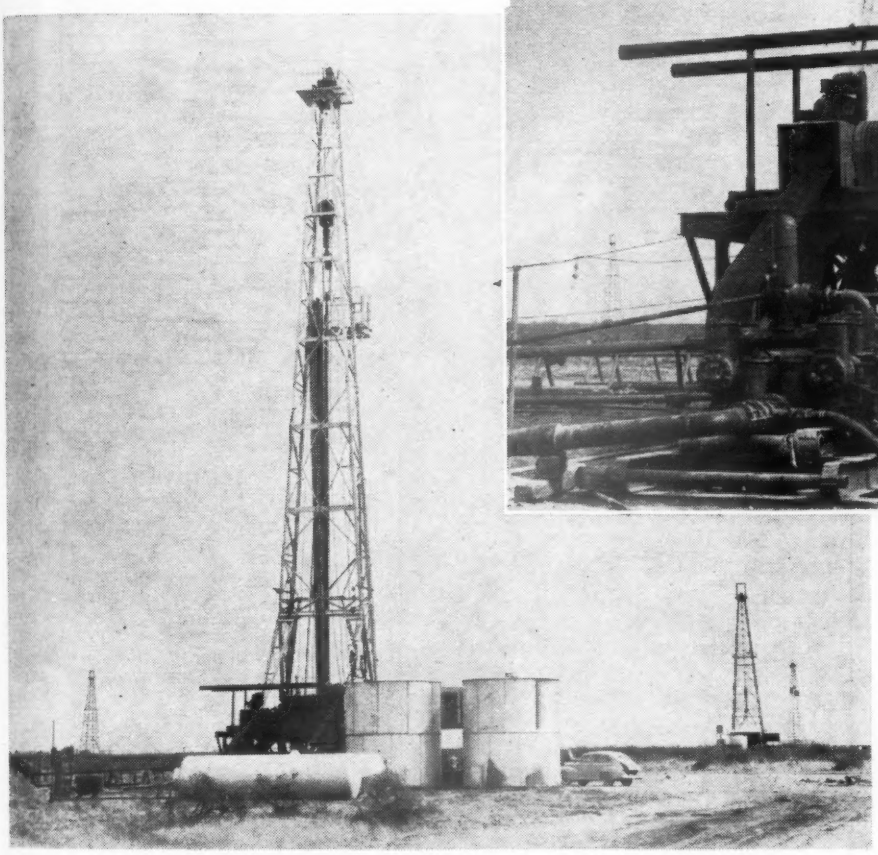
Drilling Time Cut

Although Magnolia's discovery well required about 348 days to drill, test, and complete, the total drilling time on Magnolia's Roy Glass well No. 2 in section 36 was only 160 days. General American's discovery well was completed in 178 days. Further reduction in drilling time may be expected as development proceeds and less time is needed for testing and making extra roundtrips with the drillstem, particularly below 10,000 ft.

A total of 246 rock bits were used in drilling the Pegasus discovery well. Two 17½-in. bits were used to 423 ft, where 13⅜-in., 48 lb, surface casing was set and cemented with 300 sacks. A 12¼-in. hole was drilled to 8902 ft with 117 rock bits, and 9⅝-in., 47 lb and 43.5 lb, N-80 casing was set and cemented with 360 sacks. An 8⅝-in.

Opposite page: Running drill pipe in hole soon after drilling surface pipe plug on Trebol, Rodman et al's Peck No. 1. Note the welded pipe rack skids in the foreground, which are in position to receive drill pipe or casing when delivered to the well site. At right, another view of jackknife type rig. Two engines operate the one slush pump and drawworks.





Trebol, Rodman, et al No. 1 J. F. Peck (foreground) is the second operation west of the Sweetie Peck discovery well (lower right). Sinclair's Sanders No. 1, the north offset, is at lower left.

hole was drilled to 13,087 ft with 107 rock bits, and 7-in., 32 lb and 29 lb, N-80 casing was set and cemented with 985 sacks. Twenty 5⅞-in. rock bits were used in drilling from 13,087 to total depth of 13,295 ft.

Two conventional core heads and six 6⅛-in. diamond core heads were used to core below 8902 ft in the Pennsylvanian.

Drilling Mud Data

The drilling mud weight was kept between 9.4 and 10.0 lb per gal to 9350 ft. From there to 13,295 ft, the weight was increased to about 10.5 lb per gal. The viscosity ranged from 40 to 60 sec down to 11,000 ft. From there to 13,295 ft, it ranged from 60 to 160 sec Marsh funnel viscosity. The ph reading down to 8900 ft ranged from 4 to 6. From there to 13,295 ft, it ranged from 9 to 11.

Salt content of the drilling mud ranged from 11 to 19 per cent down to 8902 ft. From there to 13,295 ft, the salt content was reduced gradually from 2000 ppm to 1200 ppm. The water loss of the mud ranged from 6 to 34 cc down to 8902 ft. From there to 13,295 ft, it was kept between 5 and 6 cc most of the time, exceeding 12 cc only once.

Mud cake thickness ranged from 2/32 to 4/32-in. to 8902 ft. From there to total depth, mud cake thickness was kept about 2/32-in. Calcium content of the mud was medium to high down to 8902 ft. Below that depth, calcium content was reported "nil".

A total of 261.3 tons of weight materials were used in drilling the Pegasus discovery. Other items and quantities are: Salt water gel, 231.3 tons; fresh water gel, 99.6 tons; lost circulation material, 103 tons; starch, 29,150 lb; preservative, 5000 lb; caustic soda, 7900 lb; tannic acid material, 12,100 lb; soda ash, 4800 lb; bicarbonate of soda, 5300 lb; and other materials,* 1400 lb.

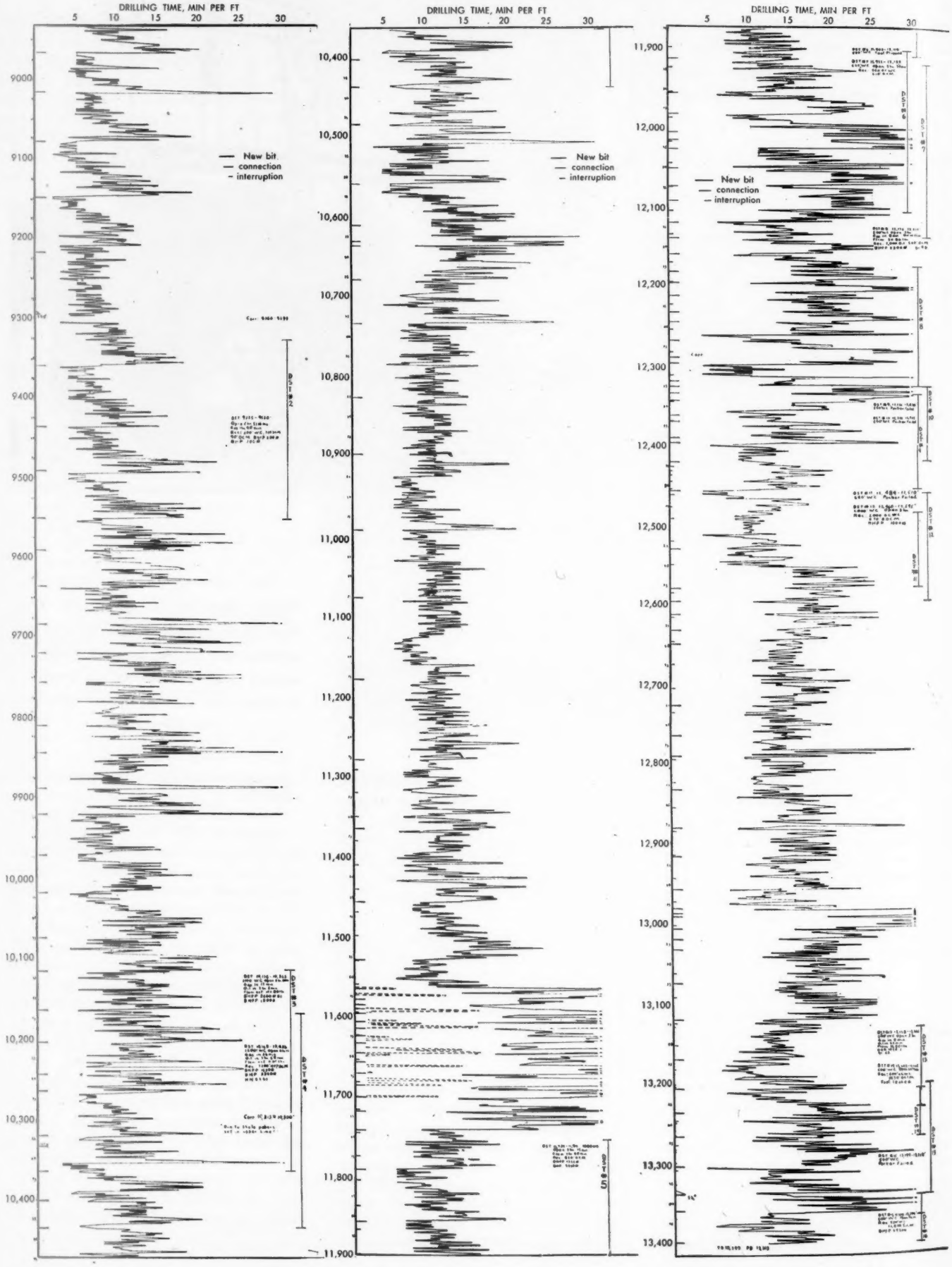
Rock Bits

A total of 189 rock bits were used in drilling the Sweetie Peck discovery well. An 11-in. rock bit and a 17½-in. rock bit and reamers were used to drill 335 ft, and 13⅜-in. casing was set and cemented at 315 ft with 325 sacks. A 12½-in. hole was then drilled to 4608 ft with 11 rock bits, and 9⅝-in. casing was set at 4606 ft with 2500 sacks of cement. An 8¾-in. hole was drilled to 9294 ft, and 7⅝-in. casing was set at 9283 ft and cemented with 300 sacks. Fifty-five bits were used.

A 6¾-in. hole was then drilled to 13,338 ft with 119 rock bits, and 5½-in. casing was run to 13,336 ft and cemented with 100 sacks. Top of cement was found at 10,480 ft by temperature survey. Casing was perforated at 10,470 ft. with two ½-in. holes, and cemented with 150 sacks. A

*Dricose.

FIG. 3. Drilling time record on General American's Peck No. 1, the discovery well of the Sweetie Peck Ellenburger field of Midland County, Texas.



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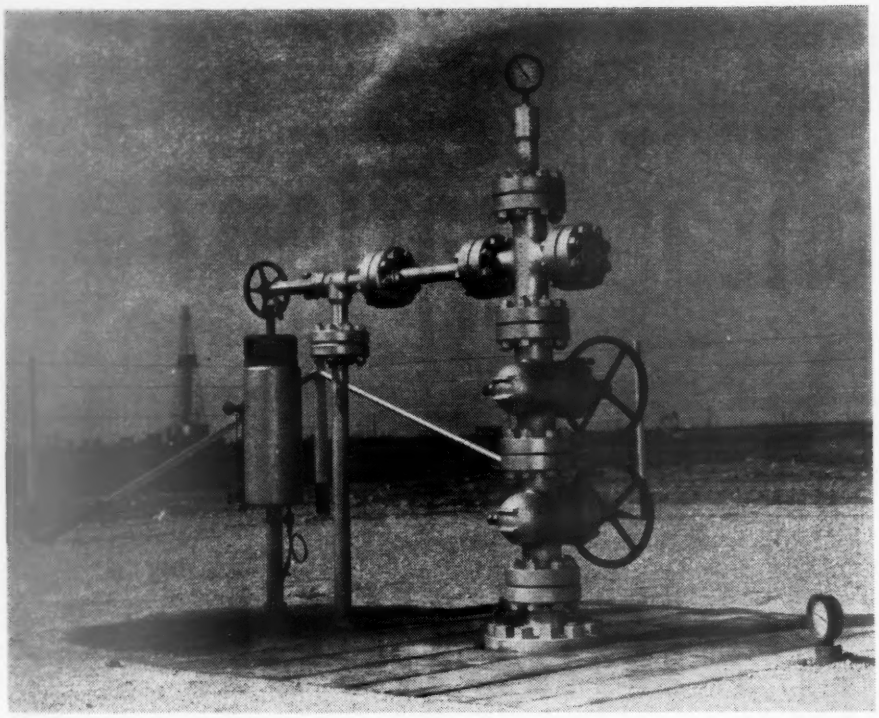

A 10,000 lb-test Christmas tree on Magnolia's Roy Glass No. 2, Section 30 in the Pegasus field. Lubricator (at left) feeds paraffin solvent into the flow line.

4⅝-in. hole was then drilled from 13,338 ft to total depth of 13,399 ft with two rock bits.

Clear Water Used

The Peck well was drilled with clear water and natural mud to 7200 ft, where circulation losses required mudding up and use of lost circulation materials. From 7200 to 9200 ft, the mud weight ranged from 9.1 to 9.6 lb per gal, viscosity ranged from 31 to 38 sec, water loss ranged from 47 to 72 cc, filter cake thickness ranged from 6/32 to 12/32-in., and the salt content ranged from 25,000 to 40,000 ppm

After setting the 7⅝-in. casing at 9283 ft, the lost circulation material was removed from the drilling mud. The weight was raised to 10 lb per gal and the viscosity was increased below 11,000 ft for drilling through shale. From 11,000 ft to 13,340 ft, the weight ranged from 9.5 to 10.0 lb per gal, viscosity ranged from 48 to 137 sec, water loss was reduced gradually from 11 to 7.2 cc, filter cake thickness was maintained about 2/32-in., and the salt content went down from 1300 to 900 ppm.

Drillstem Tests

Twenty-four drillstem tests were made on the Pegasus discovery well. Fifteen recovered oil and/or gas or showings of oil and gas. Six tests recovered only drilling mud. The packers apparently failed on two tests, and the last test, from 13,295 to 13,256 ft, recovered 180 ft of salt water and gas-cut mud.

Sixteen drillstem tests were made on the Sweetie Peck discovery well. Ten recovered oil and/or gas or showings of oil and gas. One test recovered only mud. The packers failed on four tests, and the last test, from 13,304 to 13,399 ft, recovered 12,804 ft of oil and gas-cut sulfur water.

Initial Production Tests

The Pegasus discovery well flowed 1167 bbl in 24 hr through a ¾-in. positive choke on 2⅜-in. tubing. Tubing pressure was 300 psig, gas-oil ratio was 1403 cu ft per bbl, and the oil gravity was 53.3 deg API.

The General American Peck No. 1 flowed 1056 bbl in 24 hr through a 1-in. choke on 2⅜-in. tubing. Casing

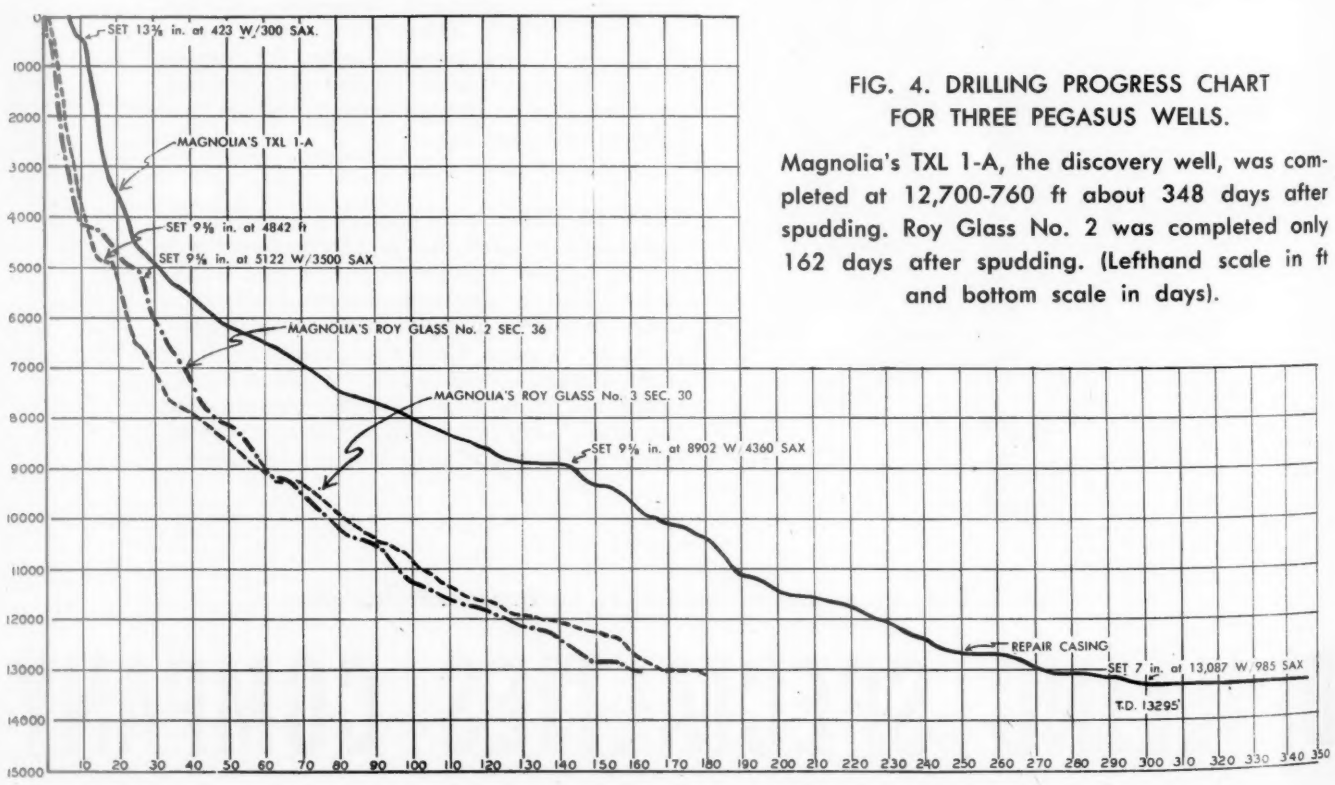

FIG. 4. DRILLING PROGRESS CHART FOR THREE PEGASUS WELLS.

Magnolia's TXL 1-A, the discovery well, was completed at 12,700-760 ft about 348 days after spudding. Roy Glass No. 2 was completed only 162 days after spudding. (Lefthand scale in ft and bottom scale in days).

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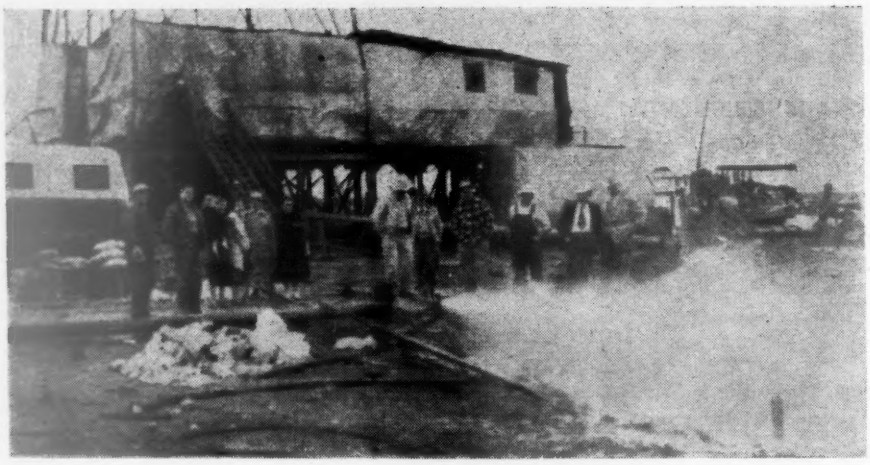
TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS



Witnessing a drillstem test on General American's Peck No. 1, the Ellenburger discovery well in the Sweetie Peck field.

Skid-mounted drilling mud shaker with electric motor power for tables rests on pipes across the circulating pits.

pressure was 450 psig, tubing pressure was 175 psig, gas-oil ratio was 922 cu ft per bbl, and the corrected gravity of the oil was 53.1 deg API.

Cost of Wells

Although the Ellenburger discovery wells in these two fields cost $400,000 or more to drill, test, and complete, future Ellenburger wells may not cost more than $300,000 to $350,000. Savings are possible with fewer drillstem tests and more experience in drilling through the salt and lost circulation sections.

Differences have already been noted in the drilling characteristics of the formations in one part of the field as compared with another part. Round-trip time for changing bits below 10,000 ft now averages about 12 hr. This may be improved some, and drillers may make more footage per bit as they gain more experience.

Devonian wells may be drilled and completed for about $250,000, and Pennsylvanian wells may be made for about $150,000.

Allowable Production and Price

The allowable production for 13,000-ft wells is now 500 bbl per day. The posted price for the sweet, high-gravity oil is $2.58 per bbl. Devonian wells (between 11,500 and 12,000 ft) would have an allowable of 310 bbl per day. Pennsylvanian wells (between 10,000 and 10,500 ft) would have an allowable of 230 bbl per day, according to a new discovery allowable order issued by the Railroad Commission of Texas. These discovery allowables may be granted for 18 months or until 6 wells have been completed in each zone of each field, and are intended to encourage the development of new oil fields.

Prove Huge Reserves

Although all estimates of proved reserves are now without the benefit of core analysis, production history, and many of the other tools, the two fields may be considered proved for 150,000,000 bbl. Pegasus may be considered proved for 125,000,000 bbl from all the producing formations discovered and indicated productive so far in an area of some 5000 acres. Sweetie Peck may be considered proved for 25,000,000 bbl from all the producing formations in an area of some 1000 acres.

There is a reasonable possibility that the two fields may produce 300,000,000 bbl, Pegasus accounting for 200,000,000 bbl from some 10,000 acres, and Sweetie Peck accounting for 100,000,000 bbl from some 5000 acres. 'Guesstimates' of this kind now range from 25,000 to 75,000 bbl per acre with the limits of the producing areas yet to be defined by drilling.

Well Spacing

The Ellenburger wells are being drilled near the center of 40-acre tracts in both fields. Some locations have been skipped in the Pegasus field, but it is believed that 40-acre spacing will be adopted. Operators in the Sweetie Peck area are already planning to drill one well to each producing zone on each 40-acre tract. This indicates that 75 wells may be drilled on the 1000 proved acres, or three wells to each 40-acre tract. In Pegasus, 375 wells may be drilled on the 5000 proved acres.

Should 5000 acres become proved and developed in this manner in Sweetie Peck, 375 wells will be required. It would take about 36 drilling rigs operating steadily for 3½ years to drill that many wells at an average rate of 120 days per well.

$100,000,000 for Wells

A 375-well program at Sweetie Peck would cost $93,750,000 at an average cost of $250,000 per completed well, including lease equipment. A 750-well program at Pegasus (to develop the possibly proved area of 10,000 acres would cost twice that amount, or $187,500,000, making the total development cost in both fields nearly $300,000,000. Full development of the proved area now in both fields will cost more than $100,000,000.

Drilling activity in these fields is increasing. Production and core data are now being obtained that will tell whether these fields are as large as indicated and whether development will reach the proportions outlined above.

* * *

Development of the Dukhan Field, Qatar*

Export of oil from the Shaikhdom of Qatar began on December 31, 1949, when the tanker "President Meny" sailed from Umm Said with a cargo of crude from the Dukhan field. This is the story behind that first oil shipment.

THE Qatar Peninsula, which juts northward into the Persian Gulf from its southern shores, has an area of roughly 5000 sq miles. The shallow seas, which fringe its low, sandy, and unattractive shores, are filled with reefs, some of which emerge above the surface at high tide, while others are permanently covered, and all render access difficult. The Peninsula itself is flat, featureless, and devoid of vegetation except for two or three struggling date gardens and a scanty scrub upon which camels can exist. The inhabitants, who total a few thousand, consist of dwellers in the four or five settled but miserable villages, and of nomadic camel folk. Camel breeding and fishing have been, throughout history, the sole resource of the inhabitants except for some excursions (now discontinued) into the arms and slave traffic of the early 19th Century, and pearl fishing, which has provided such wealth as the Qataris have ever known and founded the fortunes of its wealthier families. Today the oil industry towers above all other occupations on the Peninsula, employs the greater part of its employable manpower, and will provide the finance upon which the organization of the State must be based. It may be hoped that with this new and relatively enormous source of income, the Government and people of the Peninsula will enjoy a higher standard of life than has ever been their's in the past; there will, for the first time, be security, schools, clinics, and some, at least, of the amenities of the modern age.

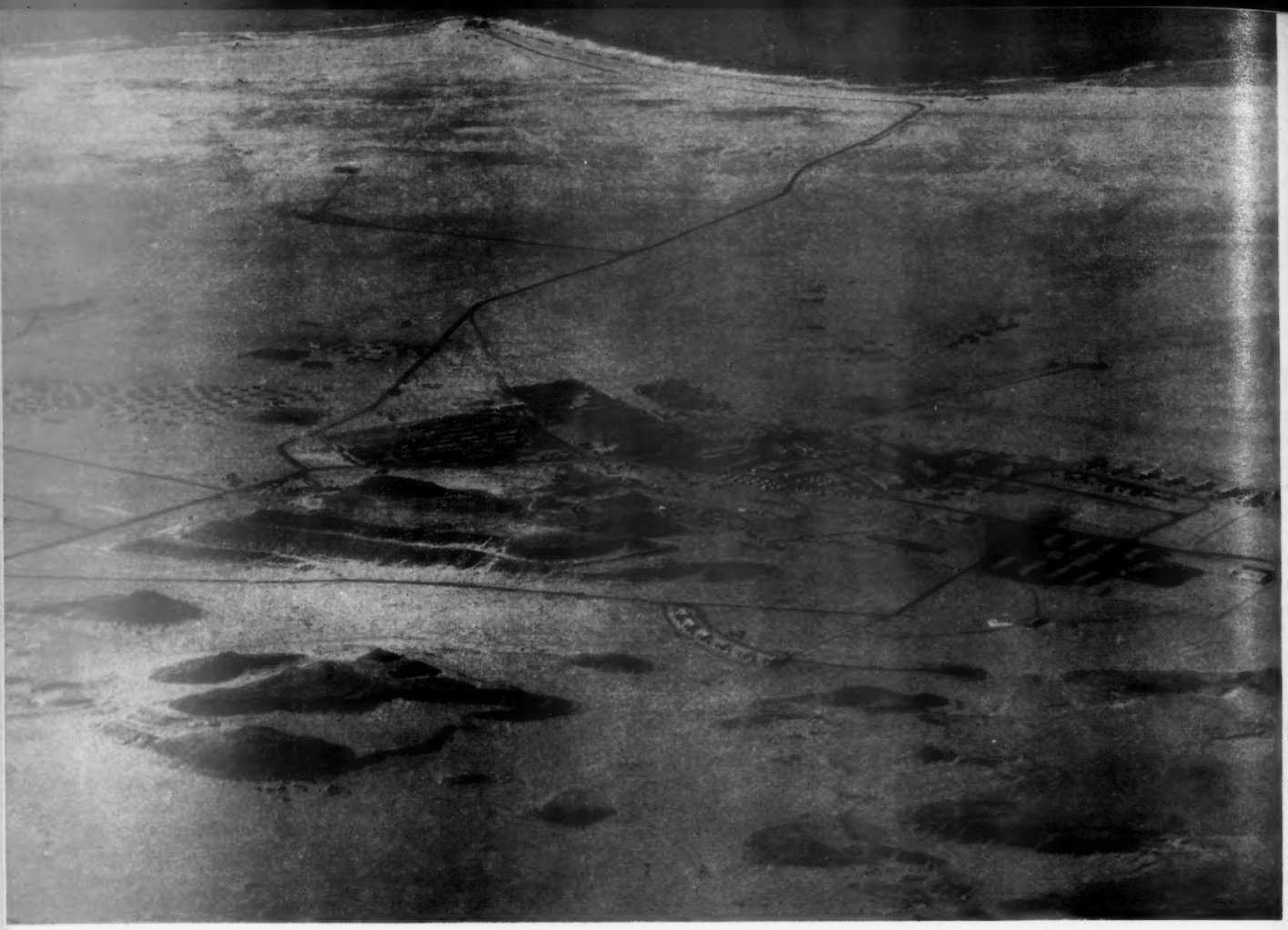
Qatar remained from 1904 until 1949 under the rule of Shaikh Abdullah bin Qasim al Thani, a member of the richest and leading family. He and his predecessors were in treaty relations with His Majesty's Government since early in the 19th Century. They were left completely free to manage their own affairs, and no British representative lived at Doha, the capital. In respect, however, of the obligation to abstain from piracy or slave trading, the Shaikh was bound by rules imposed by his protecting Ally, who maintained also certain rights of jurisdiction over non-Qatari subjects. In August, 1949, the aged Shaikh Abdullah abdicated, to be succeeded by his elder son, Shaikh Ali. The new Shaikh will be assisted, it is believed, by a British adviser and has agreed to the organization of a police force on modern lines, a reform for which the need had become extremely pressing. At the same time a political officer, or assistant political agent, has taken up residence at Doha as representative of the political resident of the Persian Gulf, whose headquarters are at Bahrein. By these means, it is expected that the new resources of the Qatar Government, to be derived from their oil royalties, may be spent to the advantage of the local public, security maintained, and public services provided.

The Concession

On May 17, 1935, Shaikh Abdullah granted an oil concession to the Anglo-Persian Oil Company, Limited, acting on behalf of the Iraq Petroleum Company Group, giving them the exclusive right to search for, extract, and export petroleum and natural gas. The Concession, which covered the whole of the Shaikh's do-

Well No. 8, Dukhan field, Qatar

*Courtesy of the Iraq Petroleum Company, Limited, 214 Oxford Street, London, W. I.



A general view of Dukhan showing the field warehouse, shop, and camp buildings, the residential section, and the roads to several of the well sites.

main, was for a period of 75 years. Petroleum Development (Qatar) Limited was organized by the members of the I.P.C. Group in August, 1936, and Shaikh Abdullah formally agreed to the transfer of the Concession to this company on October 3, 1936.

Geology

The greater part of the Peninsula is covered by wind-blown sand, but with numerous outcrops of Eocene limestone except in the dune country in the southeast. Structurally, it is a broad anticlinorium with the well-defined Dukhan anticline running along the western margin latitudes 24 deg 50 min and 25 deg 30 min, like the thumb of the right hand laid palm downward on a map of the Peninsula. Surface elevations rise to 250 ft in comparison with elevations of from 120 to 170 ft prevailing over the remainder of the Peninsula. Dips in the exposed limestones are very low, but elevations taken on marker beds revealed the presence of a surface anticlinal structure some 50 miles long and up to five miles wide with some 300 ft of closure. The geological succession established by drilling is as follows:

The Khatiyah degassing station and flow tanks.

Presenting

THE NEW

EMSCO D-850

DUPLEX POWER SLUSH PUMP

Here's a pump designed to meet the specialized requirements of deep drilling. A duplex power pump that gives you a combination of pressures and volumes heretofore unobtainable. No longer do you need to employ costly, complex systems for compounding two power pumps. No longer is it necessary to lose drilling efficiency due to the pressure and volume limitations of ordinary slush pumps. The D-850 incorporates many new and exclusive features which insure maximum efficiency and an absolute minimum of maintenance. It will pay you to investigate the D-850—the newest addition to the world-famous, field-proven Emsco line of all-steel "D" Series Power Slush Pumps.

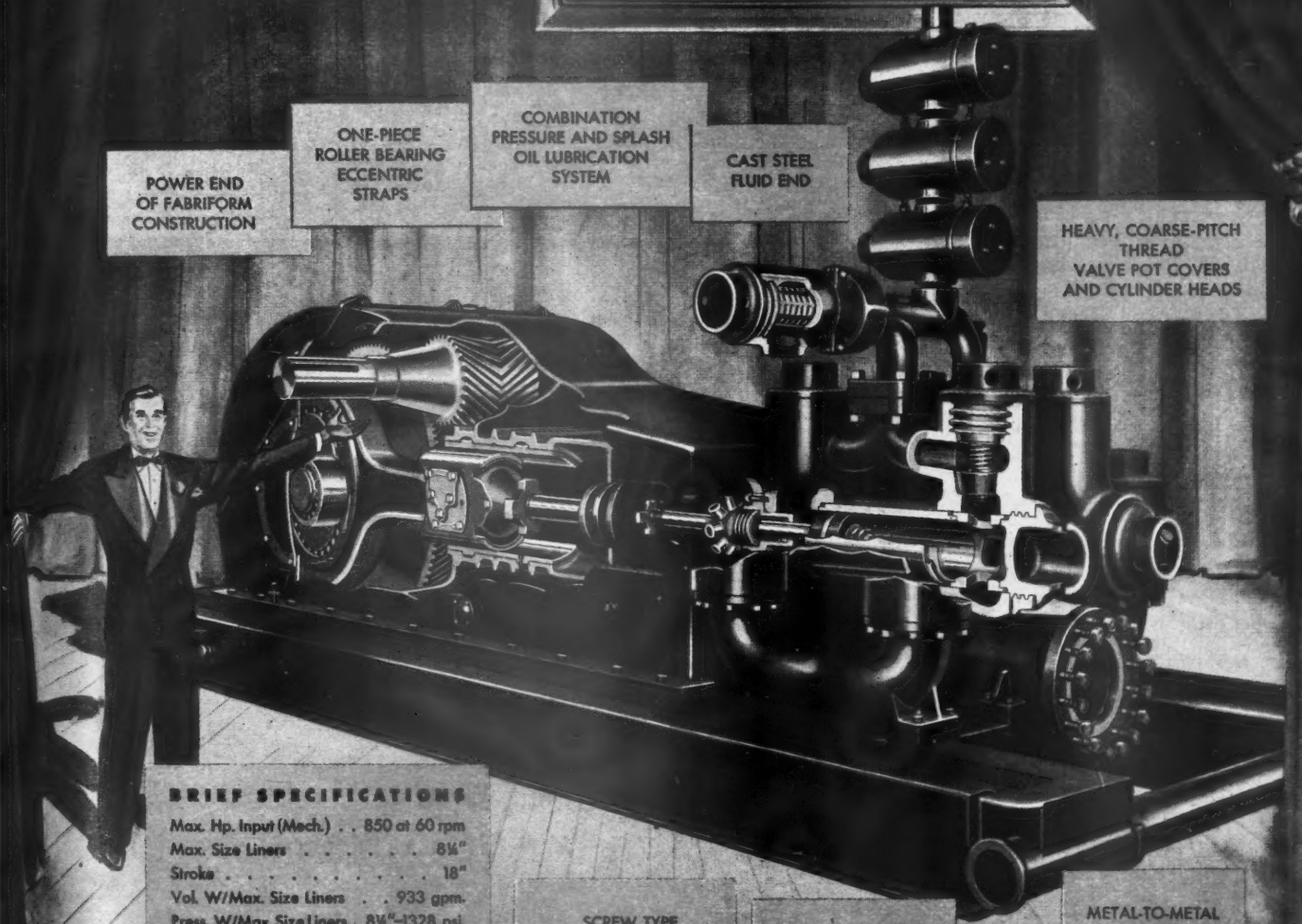
POWER END OF FABRIFORM CONSTRUCTION

ONE-PIECE ROLLER BEARING ECCENTRIC STRAPS

COMBINATION PRESSURE AND SPLASH OIL LUBRICATION SYSTEM

CAST STEEL FLUID END

HEAVY, COARSE-PITCH THREAD VALVE POT COVERS AND CYLINDER HEADS



BRIEF SPECIFICATIONS

Max. Hp. Input (Mech.)	850 at 60 rpm
Max. Size Liners	8¼"
Stroke	18"
Vol. W/Max. Size Liners	933 gpm.
Press. W/Max. Size Liners	8¼"–1328 psi.
Press. W/Min. Size Liners	6"–2680 psi.

SCREW TYPE STUFFING BOX GLANDS

LINERS PACKED AT BOTH ENDS AND EXPOSED TO VIEW

METAL-TO-METAL SHOULDERING OF LINERS

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NEW BULLETIN ★ Bulletin F-170 describes and illustrates the new Emsco D-850 Slush Pump. Your letterhead request will receive prompt attention.

Adv. #44-50

EMSCO

Age	Local name	Development	Thickness, feet
Eocene	Bahrein formation	Limestone with shales	1000
Maestrichtian	Tayarat limestone	Limestone	600
Lower Senonian	Khatiyah formation	Limestones and shales	800
Cenomanian	Mauddud limestone	Limestone	200
Lower Cretaceous	Rutbah sandstone	Sands and shales	500
Cretaceo-Jurassic	Musandam formation	Limestones with subordinate shales	2000
Jurassic	Zekrit formation	Anhydrite	400
		No. 1 Limestone	35
		Anhydrite	30
		No. 2 Limestone	20
		Anhydrite	50
		No. 3 Limestone	84
		Anhydrite	60
		No. 4 Limestone	133+

The Zekrit formation, which is correlative with the Arab zones of Saudi Arabia, lies at a depth of 5100 ft at the crestal portions of the Dukhan structure. Southward and eastward thickening of the overlying Eocene, Cretaceous, and Cretaceo-Jurassic formations reduces the size of the Zekrit reservoir in comparison with the surface Eocene structure.

Development

An exploratory well was begun at the north end of the Dukhan structure in October, 1938, and was completed in the No. 3 Limestone of the Zekrit formation in January, 1940, where it gave an estimated initial production of 5000 bbl of oil per day at a wellhead flowing pressure of 367 psi. A second well was drilled 10 miles south of No. 1 and in March, 1941, gave an initial production of 5000 bbl of oil per day at a wellhead pressure of 342 psi from the No. 3 Limestone. This well was deepened to the No. 4 Limestone, which was gas-bearing, and was subsequently plugged back to the bottom of the No. 3 Limestone. A third well, drilled 2½ miles east of No. 1, was completed in edgewater in both the No. 3 and No. 4 Limestones in May, 1942. Shortly afterward operations were suspended for the duration of the war, the wells plugged and the equipment removed. Operations were resumed in 1947 and nine productive wells have been drilled at the north end of the structure.

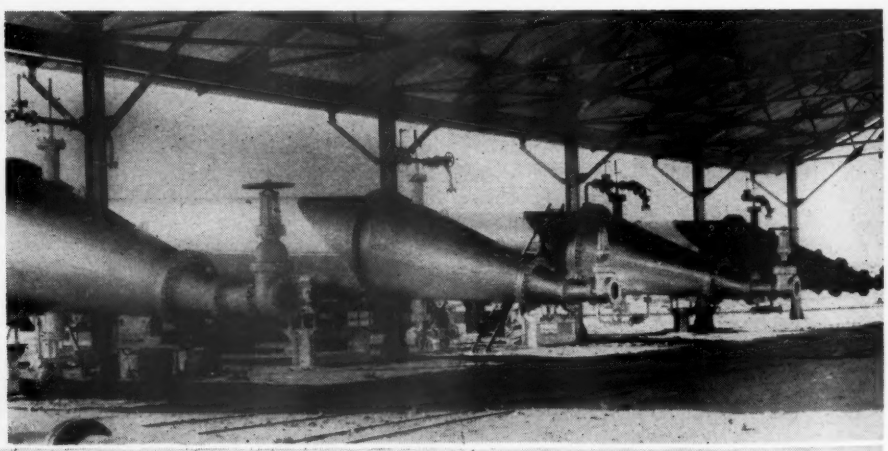
Post-war wells were drilled by rigs* powered by diesels. Due to the acute shortage of fresh water, sea water is used for circulation, which in the dry, porous Eoecene limestones is blind. These are isolated by a conductor string cemented in the Tayarat limestone, and drilling is continued with overhead circulation using clay suspensions. The use of sea water and the saline content of formation waters cause flocculation of bentonite-based suspensions. Starch suspensions, Zeogel, and soda ash have been employed. Quebracho is used as a viscosity reducer. Fibrotex and Jelflakes are used as sealing media. A water string is cemented at about 4000 ft in the Musandam formation and an oil string in the 50-ft anhydrite immediately above the No. 3 Limestone.

*Ideal 100 Consolidated.

Gathering System

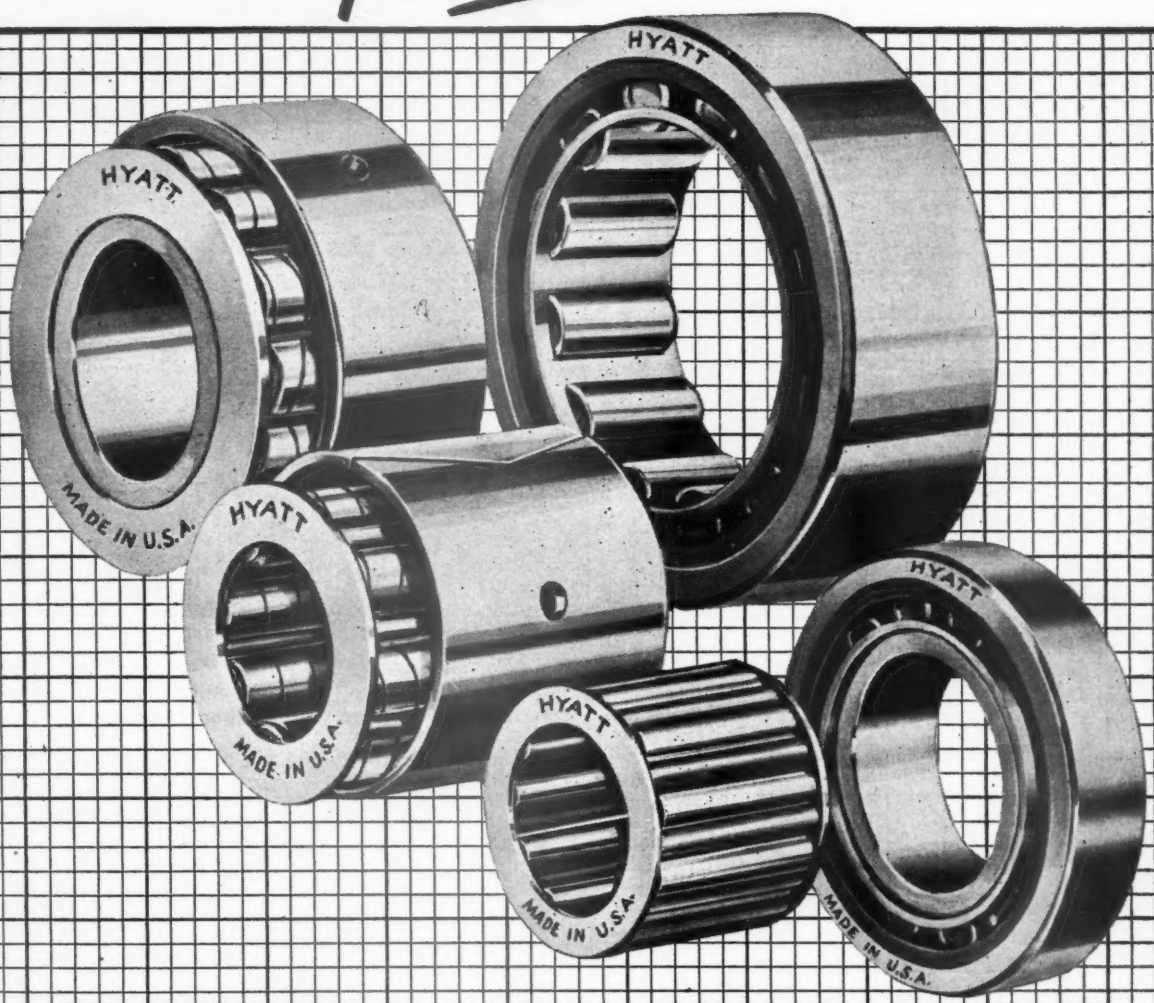
Each well is equipped with a wellhead separator from which crude flows to a central multi-stage separation unit at Khatiyah, consisting of four horizontal separators operating down to atmospheric pressure. Adjacent to the multi-stage separation unit are two 30,000-bbl storage tanks from which the crude is pumped through 20 miles of 12¾-in. and 53 miles of 14-in. pipe line to take the loading terminal at Umm Said on the east coast of the Qatar Peninsula. A temporary pump station at Khatiyah is equipped with three slush pumps driven by diesel engines.* At Umm Said are five 130,000-bbl tanks and five more, each

*Paxman.



At right is a closeup of Khatiyah degassing station under construction and below is a more general view after it was completed.

HYATTS *pay off* in performance



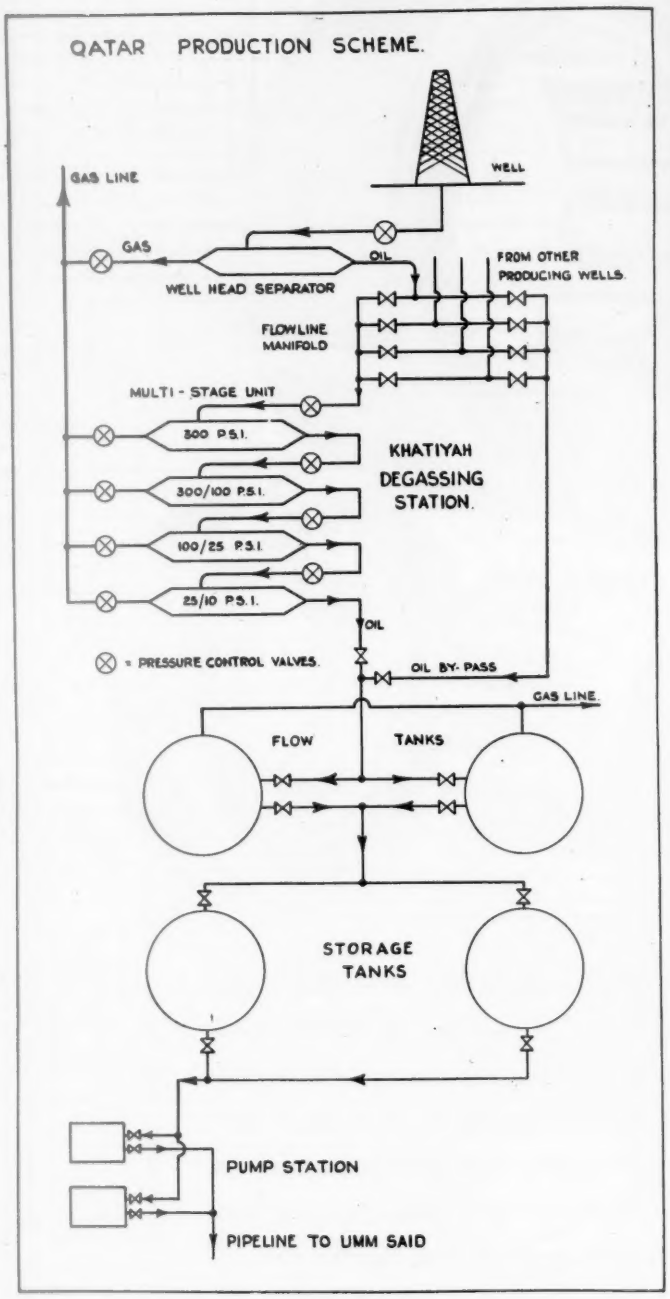
Hyatt Roller Bearings are purposely designed and built *first* to *last.*

And in every application, Hyatts have proved their correct design and built-in quality by their profitable performance in endless types of machines and equipment.

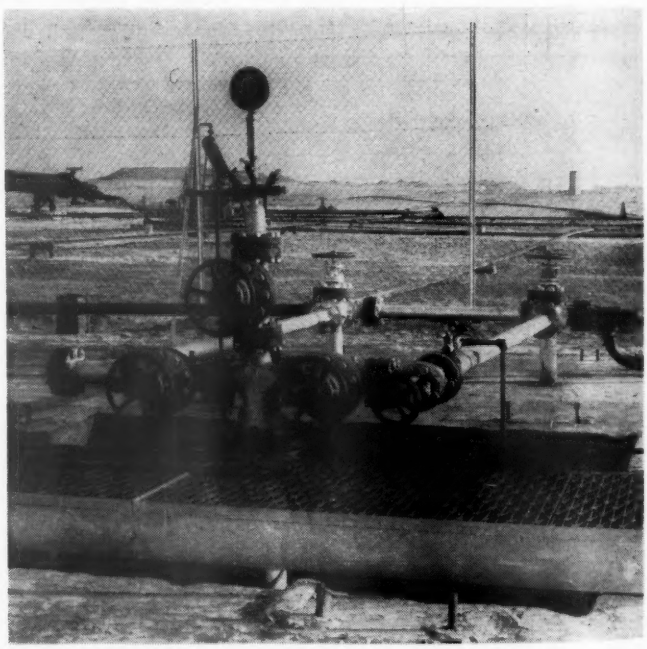
Profitable to the user because of their long-life, ease of maintenance, economy in lubrication and freedom from idle time. Wherever Hyatts are used and for more than half a century in all kinds of applications, it has been proved that Hyatts pay off in performance. Hyatt Bearings, Division, General Motors Corporation, Harrison, New Jersey-

HYATT ROLLER BEARINGS

Kekrit Harbor, right, on the west coast of Qatar Peninsula, through which much of the field equipment and stores were imported.



Typical well hookup with wellhead separator in background.



of 148,000-bbl capacity, under erection. From the terminal, oil is loaded through two double 16-in. sea-lines, each 4200 ft in length.

To make possible the export of oil from the Dukhan field, Petroleum Development (Qatar) Limited have not only had to drill nine productive wells and construct a 73-mile pipe line since the resumption of operations in 1947, but have had to provide all the supporting services that are normally available in industrial countries. They have had to provide for every need of their personnel; to build houses and a hospital; to provide power and plumbing; to construct a port and an airfield; and to import food and water. Since the commencement in 1946 of preparations for resuming operations in the Peninsula, 95,000 tons of equipment have been imported by the company, and the employment of locally-engaged personnel has risen from 200 in July, 1946, to 3400 in 1949.

Notwithstanding the efforts of the company to ameliorate in all possible ways the discomforts of life in a remote and inaccessible region, with an unpleasant, but not unhealthy climate, the amenities available are not yet comparable to those in established fields. A tribute is due to the endeavours of men who, by their hard living and hard work, have made possible this latest addition to European oil supplies from the Middle East.

* * *

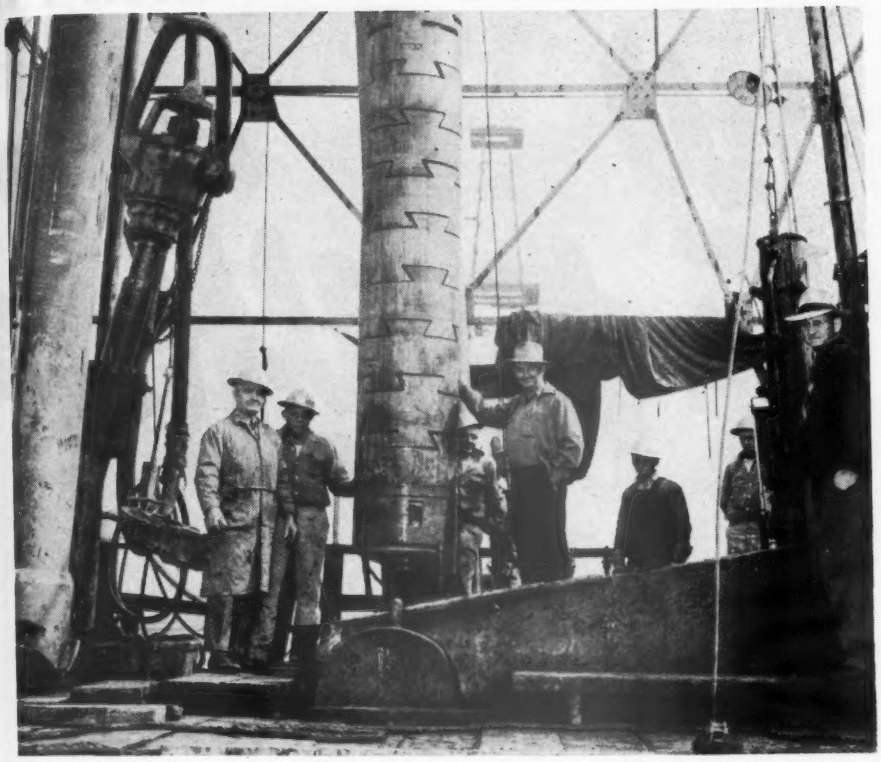


FIG. 1. Complete outside cutting assembly, with a 24-in OD cutter at the bottom of a special flexible drill stem, ready to be lowered into the well. Extreme right, Clyde Cantin, drilling superintendent, Shamrock Drilling Company.

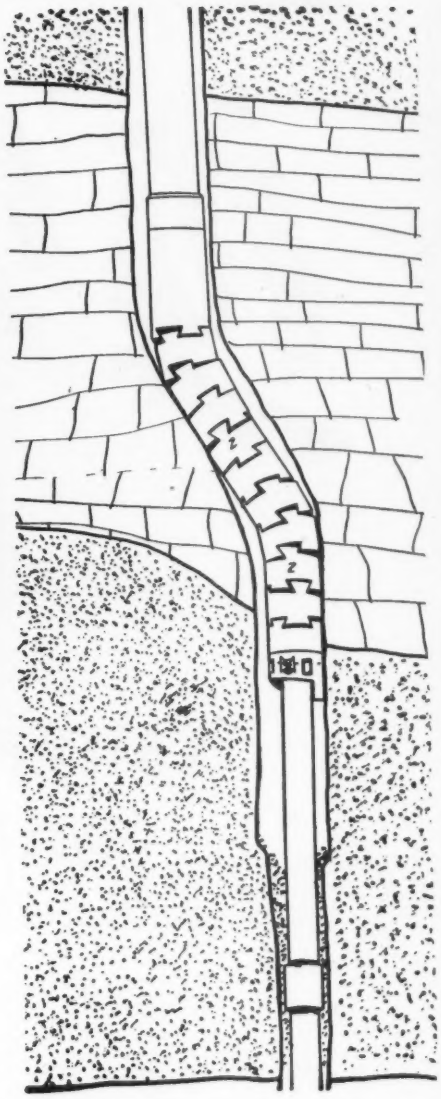


FIG. 2. Artist's conception of cutting assembly after being rotated over fish to point below offset, where cut was made

How to Repair Wells Damaged by Earthquakes

Procedure for Saving Lower Section of Casing in Original Well Below the Offset caused by a Quake

ALTHOUGH a recent earthquake at Long Beach, California, was mild at the surface, the earth was shifted or faulted at a depth of about 1700 ft, causing damage to the casing of hundreds of oil wells in the harbor area. The pipe was bent severely by the shifting formation along the fault plane as indicated by the cross-section shown in Fig. 2. The lower section of the original well is usually cemented off to prevent water from entering the producing zone. The upper section is saved by whipstocking and redrilling the well below the offset.

Certain operators* fearing that a cement plug might not prevent water intrusion into the producing zone, decided to try the method described in this article for saving the lower section of the damaged well. All the pipe was removed down to the offset at 1700 ft, and the hole was reamed out to a 30-in. diam. The kinked section was then washed over.

A special 24-in. OD cutter with a body only 15-in. long** was run in the hole on a special section of 24-in. OD flexible pipe† as shown in Fig. 1. This assembly was rotated over the upper end of the bent section of the 10¾-in. casing and lowered to a point below the bent section, where the cut was made as indicated in Fig. 2. The well bore was then conditioned to a point below the top of the lower section casing before it was contacted and re-connected with a reconditioned upper section. This is an interesting operation, the results of which will bear watching. * * *

*Shamrock Drilling Company was the contractor on this particular job.

**Manufactured by McCullough Tool Company, Los Angeles, California.
†Zublin semi-universal joints.

FIG. 3. Earthquake-damaged pipe.

SUPER TEAM FOR HANDLING SUPER INCH PIPE

It's new It's terrific

"CATERPILLAR" OFFSET D8 TRACTOR WITH TRACKSON PIPE LAYER

Offset design gives this rugged unit the balance, the lifting capacity and the spotting control so necessary for laying big pipe. It's the logical answer to the oil industry's problem of laying bigger and bigger pipe to pace supply with demand. This pipe-line tool is a *big outfit* that will handle the heaviest of today's *and tomorrow's* super inch pipe.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

Offset design of the tractor "wearing" extra wide shoes on the boom side makes this all-new unit ideal for pipe-line work no matter what the ground conditions are.

Here one of the new Offset D8s of 130 drawbar horsepower—with new matching Trackson Pipe Layer—is engaged in a wrapping operation on a 30-inch natural gas line 30 miles south of Atlanta, Georgia. This tool has the ability to handle big pipe quickly and surely.

Its hydraulically controlled counterweight (10,000 lbs.) enables the Offset D8 to handle pipe of any size on all kinds of terrain.

NEW FEATURES

1. The "Caterpillar" Offset D8 has an extended track frame on the trench side for maximum leverage.
2. The Offset D8 has extra wide shoes on the trench side to reduce ground pressures and track penetration. This improves performance when "walking" pipe in soft terrain, and reduces chances of cave-in.
3. Counterweight (10,000 lbs.) is hydraulically controlled to give the balance needed for the job. It can be quickly retracted when working tight places.
4. Has greater lifting capacity:

Overhang	4′	6′	8′	10′	12′	15′	18′
Capacity, lbs.	83,600	55,500	41,500	33,000	27,400	21,800	18,000

5. Better control of pipe. Has proper *boom* and *hook* speeds for accurate spotting of heavy pipe. Also has improved, increased-capacity drum-braking for instant control.

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Please send me additional information on the new "Caterpillar" Offset D8 Tractor with Trackson Pipe Layer.

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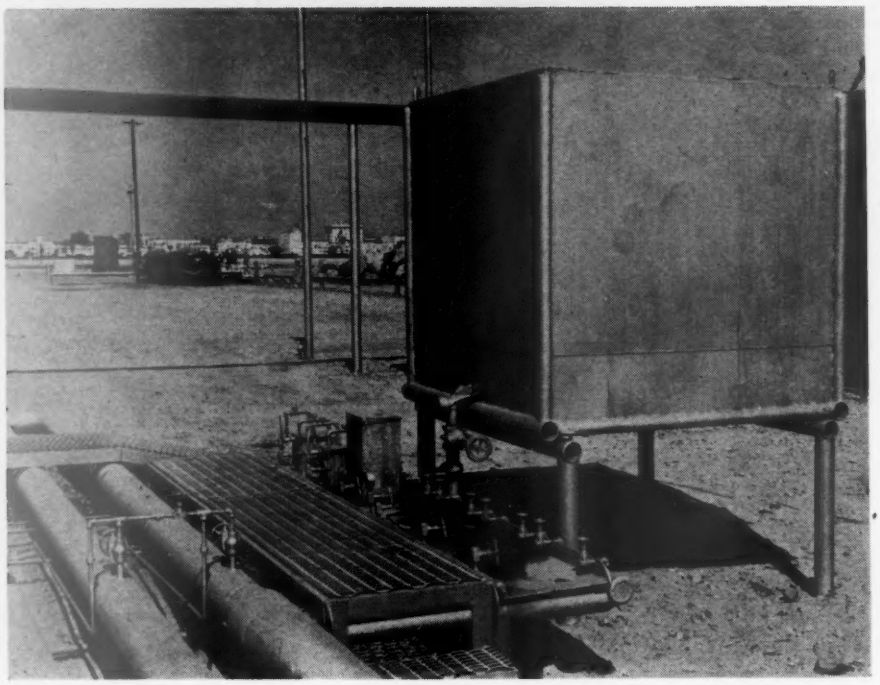


Supply tank utilitized with feeder pumps to handle chemicals.

Supply Tank at Feeder Pumps Reduces Loss of Chemicals

J. C. ALBRIGHT

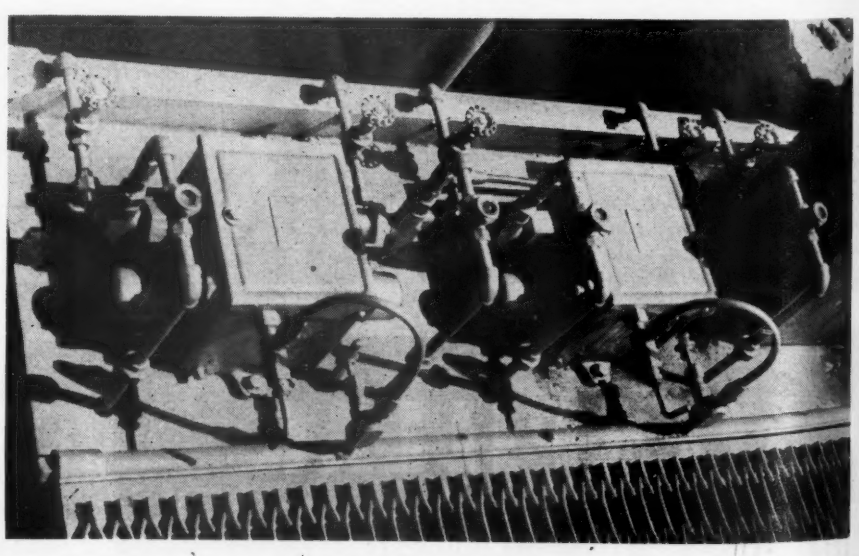
CHEMICALS used in the process of treating cut oils may be handled in bulk with a supply tank set near the injection pumps. Cumulative losses of chemicals when individual pump reservoirs are filled from pails and measuring cans may amount to a considerable item over a period of time. Richfield Oil Company has designed a special tank so that a large supply of the treating chemical is available for the pumps and is fed to the reservoirs without using buckets or other containers for transfer.

This tank is made of medium weight steel, is square in shape, and has a capacity of about 20 bbl of fluid. The sides, bottom, and top decks are flat and contain only two openings. The tank is filled by pouring from shipping containers into a large flanged opening in one side of the top deck, which is then closed with a threaded plug that has a small breather hole drilled in one side. The lower outlet is made by using a 2-in. pipe connection to the distributor header that leads to the individual chemical pumps. The construction is welded, and the corners of the vertical seams and the bottom deck welds are reinforced with pipe split or channeled to fit snugly over the square corners. The reinforcements are welded at frequent intervals by tacking. The substructure for the tank is supported by four legs made of pipe that has holes at each end to tie down the tank with bolts.

The feeder pumps are set on a trough-like support made of a wide strip of steel reinforced with angle iron that also forms the side members. Feeding, discharge, and power headers are integral with the pump support, and form part of the reinforcing portion of the supporting structure. Legs about two steps high are attached to the frame and pump support to be set in concrete grouted holes to provide stability and permanency of the setting. The outlet nipple extends through the upper part of the large side member reinforcing the tank, and is secured with three gusset plates.

The pump base is large enough, and has fittings for six feeder pumps, so that all can be set when conditions require an additional quantity of treating chemicals. Each pump is operated individually and set to deliver the desired amount of fluid through the discharge that leads to separate headers. The pumps may be combined, however, to feed into the treating vessel at the tank battery, if this method is to be followed. Connections on the fluid side of the pumps are ¼-in. pipe. The fittings on the power side of the pumps are of copper tubing with conventional compression couplings. The supply of chemical in the feeder pump reservoirs is replenished by the pumper by lifting the lid, opening the small gate valve, and permitting sufficient fluid to flow from the reserve tank to bring the level in the pump reservoir to the desired height. Losses are reduced by this method, and time is saved for other duties. * * *

EXCLUSIVE



Pumps on unitized base with manifolds for distributing chemicals.

CAN YOU AFFORD TO MUFF THE $30,000 QUESTION?

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You've probably invested about $60,000 already for a 10,000 ft. well (in the Gulf Coast Area) and it will cost another $30,000 to $40,000 to set and cement casing and for completion equipment...But what have you got?

There's where the Johnston Tester comes in. It's your answer to the $30,000 question. It tells what you've got...oil, gas, salt water...or nothing.

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FORMATION AND CASING TESTING — JOHNSTON

API Sponsors Oil-Treating School Operated by Wyoming University

The University of Wyoming department of vocational education is operating oil-treating schools in the Rocky Mountain district through the spring and summer under the sponsorship of the American Petroleum Institute division of production.

API and ASTM-approved methods of sampling are studied and compared for their application in sampling for testing oil. Types of thiefs and their use in obtaining representative samples are studied, and each man runs tests on oil samples to determine the percentage of bottom sediment and water content, with particular emphasis being given to emulsion and paraffin content in the sample. The approved methods of thiefing a tank is outlined.

Chemical injection pumps are dismantled and reassembled in the class room, each man participating in the work. Each enrollee selects a chemical compound for use in the treatment of an emulsion, using approved methods of selection by the bottle and ratio test. Each step is analyzed. The bottle test results are checked in a pilot plant, which is a part of the school's equipment.

In operation, the pilot plant resembles a flow line treating system that is often seen in the field. It is composed of plastic vessels that are transparent and in which the separation of oil and water may be observed by students attending the school.

The principles of flow line-treating are covered with reference to the interrelation of chemical, heat, and settling time. Operation and function of particular parts of the unit treater are explained through the use of wall charts.

Thirty hours of training are given, three hours per day, Monday through Friday, two consecutive weeks. The course is open to all men in petroleum production work. Morning and night classes are held. Schools have been held in Casper, Worland, and Byron, Wyoming.

Courses will be given in Elk Basin, Wyoming on May 15-26, Stanolind Oil Company's garage; Cody, Wyoming, June 5-16, Ohio Oil's Oregon Basin warehouse; Grass Creek, Wyoming, June 19-20, Ohio's warehouse; Kevin-Sunburst, Montant, July 10-21, Texas' Swayze Camp recreation hall; and Midwest Wyoming, July 24-August 4, place as yet to be announced.

Fee for the course is $15.00, which covers all costs, including the handbook on treating, laboratory equipment and supplies. A certification of completion will be given each man who completes the course. Attendance at 80 per cent of the meetings is required as a minimum. * * *

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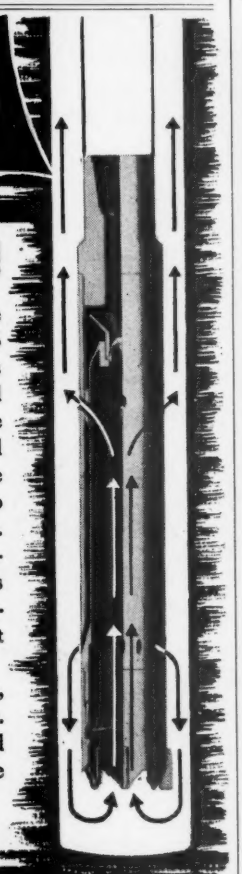

THE BOWEN JUNK BASKET uses the unique principal of reverse circulation to PULL objects into the basket. Circulating fluid is diverted through side passages in the barrel and against the full circumference of the hole. Here the fluid is deflected, moving all objects toward center. Fluid flows in a continuous stream to the center of the tool and up through the barrel to return ports pulling all objects into the catcher. This reverse circulation action assures more complete recovery of junk in the hole and eliminates misruns. *Full pump pressure can be utilized* because there's no danger of pressure bearing against and causing loss of the fish.

An ideal tool for recovering all types of junk, for coring purposes, and as a hole straightener. Comes in sizes from 4⅝" to 17½" and is engineered to recover all types of bit cones used to drill hole sizes within its range.

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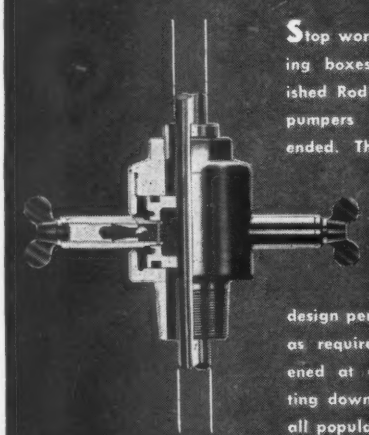

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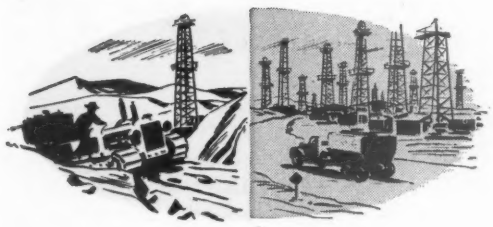
cuts cementing costs on every type of job



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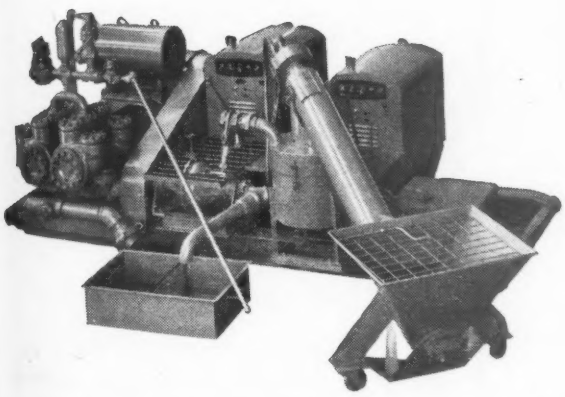

PORTABLE SKID MOUNTED POWER CEMENTING UNIT. Type 500 S combines a 5" x 8" Gardner Denver duplex pump with an ICI 10-blade mixer and fluid drive conveyor. Powered by two Mercury industrial engines — one drives the pump; the other the mixer and conveyor. When specified, skids may be extended and a calibrated water tank with necessary manifolding mounted adjacent to pump.

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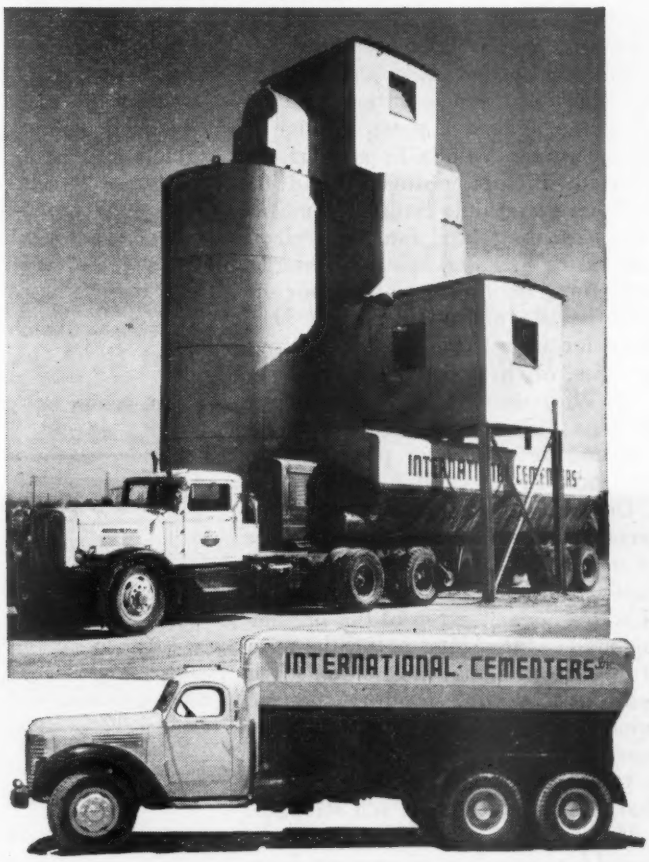
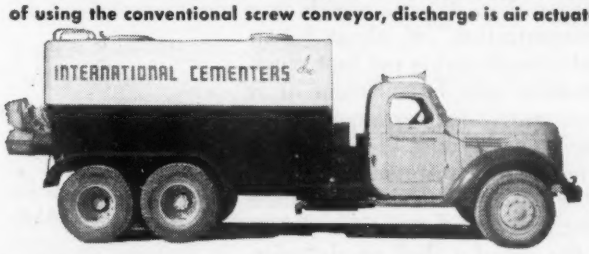
BULK CEMENT BATCH PLANT. Bulk Silos may be installed in any combination of silo units. May include a central, completely automatic, weigh batcher to handle sand, gravel, and admixtures, as well as cement. The batcher speeds up delivery, reduces labor costs, and accurately weighs the quantity and flow of the desired material or combination of materials.



AIR ACTUATED BULK CEMENT UNIT. This outstanding 250 sack bulk cement unit is similar in design to the Model 1250-T. Instead of using the conventional screw conveyor, discharge is air actuated.



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Practical Aspects of Multiple Pack-Shots for Bottle-Necked Wells

F. R. COZZENS

A MAJOR impediment to the recovery of oil, either by primary or secondary methods, is the "under-shooting" of producing wells. Under-shooting, or an insufficient concentration of nitroglycerine against a given footage of sand, usually results in a short, restricted fracture radius around the well bore, and only limited quantities of oil can be forced into the well by natural or artificial reservoir energy. Sometimes under-shooting is done unintentionally by miscalculating shell diameter in relation to sand permeabilities, or through false economy—in an effort to cut costs on well completions. More often, however, under-shooting results from problems encountered in the drilling process.

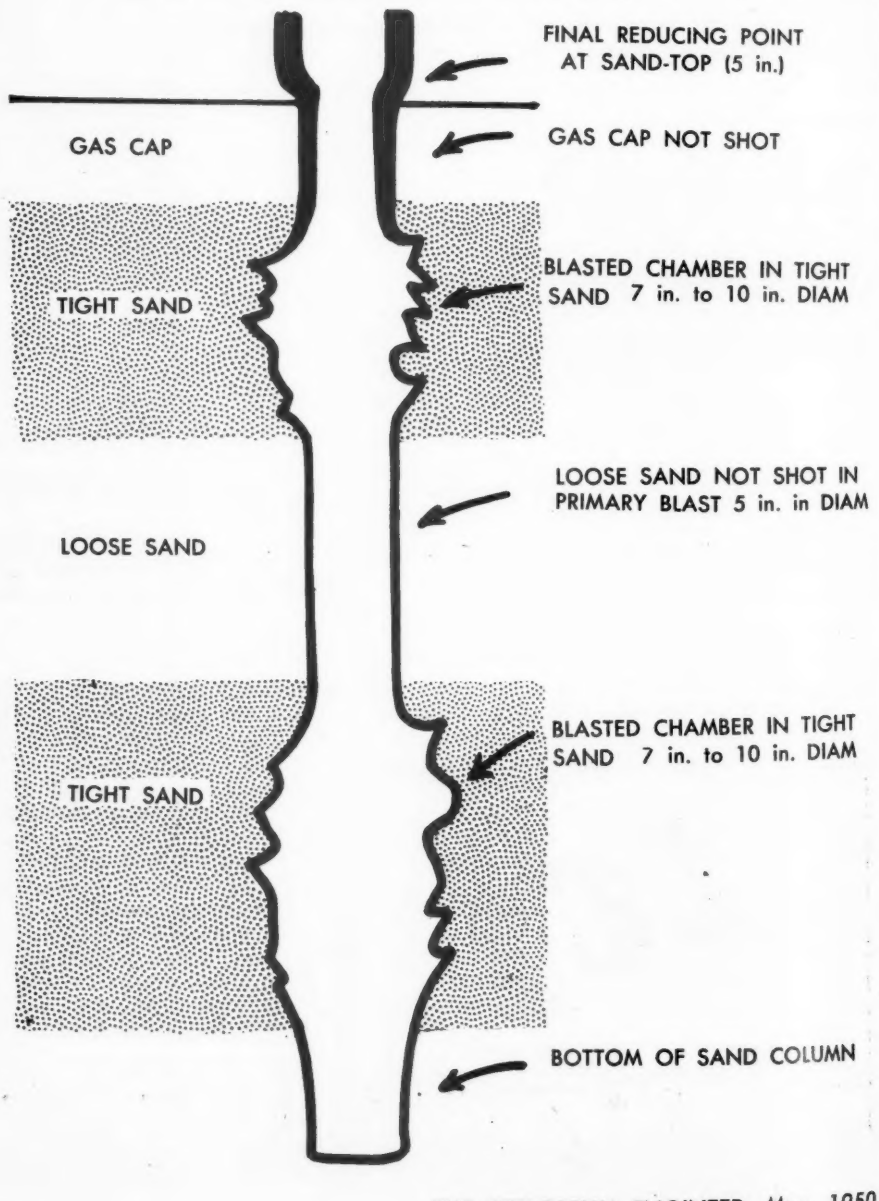
On many wells, it often becomes necessary to reduce the diameter three or more times before reaching total depth, and the smallest diameter is, of course, near the top of the producing sand. At that vital point, the most promising well may be bottle-necked and its potential fracture pattern ruined so far as general shooting is concerned, because the bore diameter is too small to admit an explosives charge of sufficient size and strength.

Many wells now being reconditioned for secondary oil recovery have top-sand diameters of 5 in. or less, which prohibits the safe running of a shell larger than 4½-in., which is a "shot-concentration" of about 3.4 qt of liquid nitroglycerine per foot. Such concentration may be sufficient or it may be excessive for certain zones of loose sand. Other zones of tight, hard sandstone may require a concentration of 6 to 8 qt, however, for adequate fracturing. Such concentrations would call for the use of a shell nearly twice the diameter of the well-bore.

Aside from dumping liquid nitroglycerine into the well-bore, which is not a safe practice or performing an expensive reaming job, the customary practice has been to shoot the entire sand-column from top to bottom with 4½ in. shells. As a result, the tight sand strata may not be fractured sufficiently. Oil in those tight sands may be by-passed during primary or secondary recovery, because of low permeability, and much of the oil may remain in place after the well has reached its economic limit of production.

For wells with small-diameter bores through tight oil sands, some operators use solidified nitroglycerine in what is called a multiple "pack-shot". The primary charge is a squib, its sole purpose being to create, at certain designated sections along the sand-bore, cavities with dimensions sufficient to receive the pack-shot, which follows later. Any section of the sand-bore may be enlarged to the necessary diameter by a squib shot regardless of the size of the well bore at the top of

Sketch of 5-in. diam sand-bore after primary pack-shot.


FINAL REDUCING POINT AT SAND-TOP (5 in.)
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GAS CAP NOT SHOT
TIGHT SAND
BLASTED CHAMBER IN TIGHT SAND 7 in. to 10 in. DIAM
LOOSE SAND NOT SHOT IN PRIMARY BLAST 5 in. in DIAM
LOOSE SAND
BLASTED CHAMBER IN TIGHT SAND 7 in. to 10 in. DIAM
TIGHT SAND
BOTTOM OF SAND COLUMN

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With many wells ranging from 6,000 to 12,000 feet in depth, pumping places a tremendous strain on the sucker rod string entrusted with bringing the oil to the surface. Each slender sucker rod unit—only 25 or 30 feet long and ⅝" to 1" in diameter—must be capable of supporting the multi-ton weight of the entire string . . . must carry the weight of the oil rising to the surface . . . must stand up under the constant whipping and reversing action of pumping.

For more than five years, Republic's field-mill-laboratory metallurgical team has worked with this manufacturer's own metallurgists—to produce a stronger, longer-lasting sucker rod for deep well pumping.

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This is but one of many important oil field applications in which Republic Alloy Steels and 3-Dimension Metallurgical Service have resulted in improved performance . . . lower production costs . . . higher productivity. What has been accomplished here can reasonably be done in *other* applications, in *other* industries.

Are you using "the right steel"? Why not call on Republic's 3-Dimension Metallurgical Service to work with your own metallurgists toward finding it—and with it, new economies and new profits. Call your nearest Republic representative today.

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the sand. The practice is adaptable to new wells or wells that have been shot previously, provided that the physical characteristics of the producing formation are known and that accurate measurements have been made of the well bore through the sand.

On new wells, multiple pack-shots may be planned as soon as the hole has been completed to the total depth or the bottom of the producing sand. From the log of the oil sand, which should be a detailed recording of oil sand samples, cores, and steel-line footage measurements, all sections of tight sand are determined. The well bore is then plugged back to the base of the first tight section. That section is then filled from base to top with solidified nitroglycerine, generally of gelatin-type, 100 per cent strength, in the following manner.

Preparing the Charge

The paper wrapper is removed entirely from the cartridges, which may be had in various commercial sizes. Each cartridge is dipped in engine oil or heavy crude. The oiled cartridges are then loaded into a dump shell, 3 to 4½ in. in diam, lowered to the desired position in the well, and the contents released. The charge should then settle into a firm, solid pack without tamping, and without much risk of bridging the hole.

When the desired length of section is filled, the charge may be detonated by electric blasting cap or by go-devil with fuse attached. The procedure is simple and comparatively safe, however, as in the use of all high explosives, it should be supervised by an authorized representative of a torpedo company. Following the blast, the hole is drilled down to the base of the next tight zone that was logged. The same squibbing procedure is repeated until the bottom of the well has again been reached and cleared.

Unless the tight sections are extremely hard or shot-resistant, a single squib blast should increase the hole diameter 3-in., or more, and thus provide a cavity about 8-in. in diameter in a well bore, 5 in. or less at the top. Should large cavity dimensions be necessary, two or more squib shots may be applied in successive treatments, using 10 to 25 lb of explosives for each squib. In this way, many cavities are made large enough to carry a concentration of as much as 33 lb per foot which is equal to about 10 qt of liquid nitroglycerine per foot.

In tight sands that are inclined to shatter quite easily, the cavity dimensions are controlled by using gelatin of as low as 40 per cent strength. Where necessary, the high-strength gelatins may be diluted by adding 5 per cent dry saw-dust or other non-metallic filler to the oiled-cartridges as they are loaded into the dump shell.

Preparing the Pack-Shots

After the oil sand has been squibbed to requirements and thoroughly cleaned out, the main charge of explosives is loaded into the well. To facilitate loading, the dump shell should be long enough to discharge 20 to 25 qt of the oil treated explosive at a single run. The shell may be operated by wire and reel or run on the sand line. The well bore from the base to the top of the sand is filled with explosive for the main charge. Loose, porous sand sections receive the minimum concentration, because of their unsquibbed well bore sections. The bulk of the charge settles into the squibbed cavities where the average concentration ranges from 5 to 7 qt per foot of sand. It is generally advisable to detonate the main charge electrically by using heavily-insulated copper wire line and blasting cap (No. 9 or larger), because more or less residue falls into the well bore on top of the charge when the casing is removed. "Stemming" is a matter of opinion. The majority of operators use water, often less than 100 linear feet over the charge, so that consider-

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Each head is furnished with a ½-inch square, endless Neoprene Packing Ring which is oil and acid resistant. Since it is molded in an endless piece, the danger of leakage is greatly minimized. Specify Hercules "BP" Casing Head for your next well. Write for Bulletin No. 305-BP.

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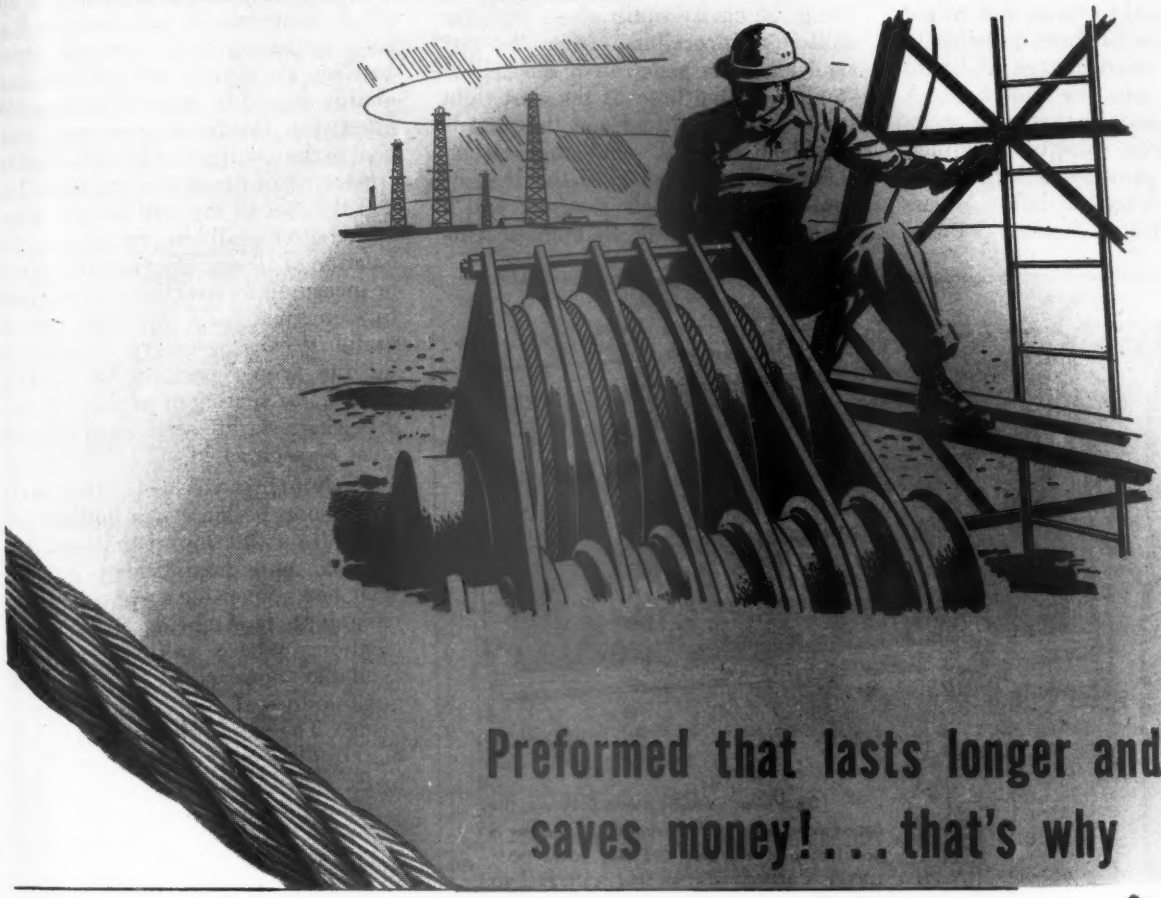

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able residue is cleared out of the hole by the blast, thus reducing clean-out time with the tools.

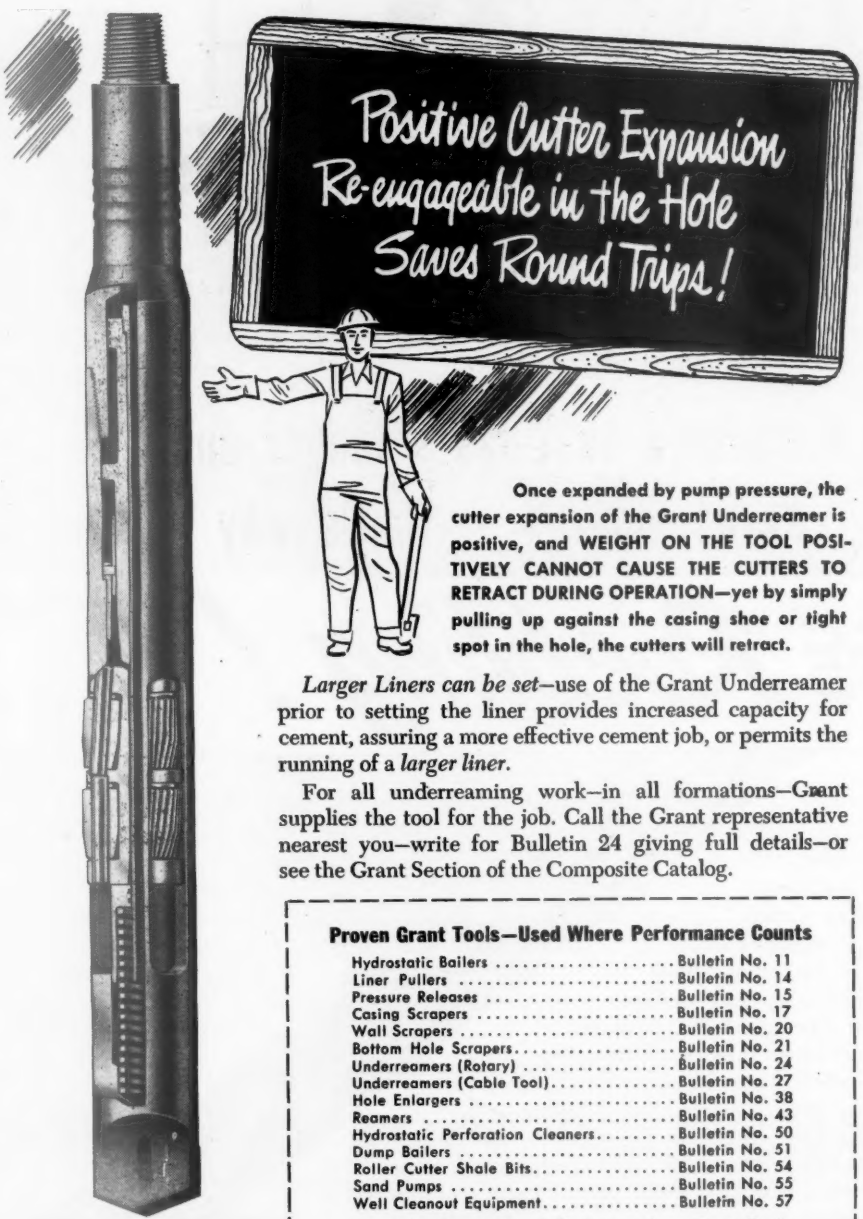
Results in many fields indicate that clean-out time and labor are about the same as when liquid nitroglycerine is used, and fracture patterns are believed to be equal to those that would have resulted had it been possible to load a similar-sized charge of liquid nitroglycerine into the well bore. A few operators believe that, due to its somewhat slower velocity, solidified nitroglycerine provides a larger and more effective fracture radius in certain sands than does the liquid form, provided the charges are heavily stemmed. Data are lacking, however, to prove or disprove this theory.

Where old fields are being redrilled, and data from surrounding wells make a dry location unlikely, shooting time and labor may be reduced further by using the cavity squib along with the drilling-in procedure. After the pay sand has been penetrated, the drill is stopped at the base of the first tight zone. Tools are lifted and the zone is squibbed without removing casing. Drilling is resumed until the base of another tight zone is reached, and a squib is applied to that zone. This practice continues until the bottom of the producing sand is reached. Few sands, however, require more than two, or possibly three squibs along the route, and the bore, after being cleared of residue, is then prepared for the main charge. It should be applied immediately and detonated as soon as the casing is removed. Delay between the squib shot and the final charge should be as brief as possible, otherwise, residue-seepage may congeal in the cavities and hinder effective fracturing of the producing sand. Unless the size of the well bore is determined after squibbing by calipers, the location of all squibbed cavities should be measured by steel line and recorded for reference. Such data may become useful or even necessary in determining the proper position for working barrels, for seating of packers, or zoning, where certain sections of the sand must be segregated.

Reshooting old wells that were under-shot, because of a bottlenecked well bore at the top of the sand, presents a more complicated problem. Well bore dimensions are usually too irregular to hold a bridge in the proper location. Where caliper service is available, however, it is often quite possible to seat an expanding type of bridge. These may be obtained in various sizes and designs. In old wells with badly guttered bores, it may be necessary to fill the shot hole (with finely pulverized dry clay) to the base of the zone that is to be reshot.

A somewhat more expensive, yet a far more practical method is to use drillable pipe as a bridge support. The pipe must be of a diameter small enough to pass through the opening at the top of the sand, and cut to a length sufficient to reach from the bottom of the well to within a few inches below the base of zone to be reshot. The prepared pipe length is lowered to position by the sand line, and a wadding of burlap, heavily-saturated with plastic compound is forced down the bore to the top of the pipe. The plastic-burlap plug hardens within a short time, so that the required charge of explosives can be dumped upon it. As the section being treated has already been enlarged to some extent by the original shot, the initial squib is seldom required. Should the section be found to hold less than four quarts of packed explosives per linear foot, however, a second charge should be applied. Well bore lengths between cavities are seldom reshot, and after the tight sand sections have been reshot, the pipe and plug are drilled out as the well is cleaned after the blast.

Although it is questionable whether



Once expanded by pump pressure, the cutter expansion of the Grant Underreamer is positive, and WEIGHT ON THE TOOL POSITIVELY CANNOT CAUSE THE CUTTERS TO RETRACT DURING OPERATION—yet by simply pulling up against the casing shoe or tight spot in the hole, the cutters will retract.

Larger Liners can be set—use of the Grant Underreamer prior to setting the liner provides increased capacity for cement, assuring a more effective cement job, or permits the running of a *larger liner.*

For all underreaming work—in all formations—Grant supplies the tool for the job. Call the Grant representative nearest you—write for Bulletin 24 giving full details—or see the Grant Section of the Composite Catalog.

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the original fracture pattern can be changed very much by reshooting, the old fractures may be opened and lengthened so that more oil may be produced into the well bore at a faster rate. Old wells may contain unsuspected obstructions, such as broken tubing, working barrels, packers, etc. Such material should be fished out, if possible, before any reshooting is attempted. The final clean-out, after reshooting, is also important, and close observation of the residue should provide clues as to the condition of the well.

In most cases, it is advisable to use strong salt water or prepared brine (100 lb granular salt to 60 gal of fresh water) as a clean out fluid. Where lime, iron-scale, mineral salts, etc., are prominent in the residue, many operators use a weak solution of hydrochloric acid (8 to 10 per cent with inhibitors) as a washing fluid. Some cases require the use of a commercial paraffin solvent, or two or three washings with drip gasoline or gasoline-treated oil. Any acid or solvent treatment should always be followed by a final wash-out with clean water.

Old wells of outstanding performance, or where situated at strategic points on a property, generally justify the cost of caliper service. A caliper log of a well bore reveals formation characteristics and reactions to previous explosives that cannot be learned nor detected by surface calculations. Such data are invaluable in future drilling and shooting within that particular area. It is now becoming an accepted practice in many eastern stripper fields to have caliper logs taken on scattered wells, over a cross-section of properties, so as to provide more accurate shooting knowledge for use with secondary oil recovery measures.

Field statistics, based on calipered wells over wide areas of stripper territory have revealed a marked prevalence of bottlenecked sand-bore tops, and their physical hindrance to the proper distribution of nitroglycerine within a sand-column. Caliper logs and production records taken on many of these restricted wells after pack-shooting treatment, indicate that satisfactory fracture systems were provided, and that the well bore diameters were increased sufficiently to provide adequate reservoirs, ranging from 3 to 10 bbl or more in capacity.

A sand reservoir, or so-called 'shot-hole', is of minor importance in bringing oil into a well, however, it provides storage space for the oil received, allowing the well to 'head-up', so as to reduce the cost and labor of continuous pumping. Pack-shooting is designed to establish these reservoirs in particular zones of sand, thus reducing the risk of opening sections that are likely to contain water. Preferred locations for reservoirs, however, are in the lower sections of sand, so that a short pocket may be drilled beneath it, and the well pumped from the top of the pocket.

Solidified nitroglycerine is not designed into pack-shots because of a preference over the liquid form. The primary objective is to provide the necessary shot-concentration for restricted areas through undersized reducing points and bore openings, where it might be impossible or impractical to apply an equal concentration of liquid nitroglycerine. The science of explosives, due to expanding research and field practice, has developed rapidly during the past 10 years, and the old-time 'straight' nitroglycerine has now become the main ingredient for a wide variety of commercial explosives, such as the gelatins, gelamites, nitro-gels, and the more common forms of blasting dynamites. All these types are available in solidified form, in a great variety of sizes and strengths, and almost all of them may be used in pack-shots for enlarging well bores in selected sections. * * *

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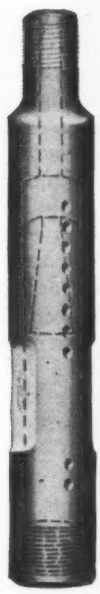

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Wire Rope Usage—Care—Maintenance†

A. J. KING*

ROPE, in one form or another, has been used as an aid to civilization throughout many centuries. A brief account of the development and usage of this important link by means of which useful energy, (primarily tensile) is converted into desired uses so essential to modern industry, is interesting, if not entirely necessary. Coincident with the ever increasing usage of wire rope as a hoisting medium is the realization of the dangers of misapplication, necessitating intimate knowledge covering intelligent selection, proper installation, effective maintenance, and adequate inspection of this indispensable tool of industry.

A tension device (today called "rope") is almost as ancient as the human race itself. In the so-called "stone age" strips of hide and pliant reeds were joined together in devious and ingenious ways, for supports and hoisting. After this crude approach a number of fibers were twisted together so that they held together by mutual friction when a force was applied, making possible longer and stronger mediums. Early in the 19th century, engineers of the day began to seek suitable and available substitutes for fibers such as some form of metal, either ferrous or nonferrous.

The only available material, that which combined both flexibility and strength, was wire—and this was utilized. The crude forerunner of the wire rope of today, was made by laying several large wires parallel to each other, and binding them together by wrapping the entire unit with fine wire. This early method of construction had its first practical application and usage as a suspension member of a bridge. Strange as it may seem, suspension cables used today are basically of the same construction, differing only in the number and size of parallel and covering wire, grade and strength of steel, and methods of fabricating the unit.

To eliminate the need for wrapping parallel wire with fine wire, the idea of twisting a small number of large wires together was conceived, and because many small wires woven together are stronger than one wire of equal diameter, many small wires were woven into units called strands, a number of which were subsequently twisted together. Although the twisting of strands into a rope provided greater strength, flexibility, a necessity when used on sheaves and drums, was very low. Strands of multiple wires of numerous designs were developed and twisted around hemp or wire cores to overcome this condition and make wire rope adaptable to wider ranges and greater usage. This provided strength, flexibility, fatigue resistance, and ruggedness (ability to withstand abrasion, distortion, and abuse) to sustain loads under conditions of occasional or repeated bending and abrasion. These characteristics distinguish wire rope from other tensile devices.

Wire rope is constructed with these characteristics today, and is defined technically as "an article or device formed wholly or in part of a plurality of wires helically twisted together to form strands or units that are laid helically around a core of fibrous or metallic material". In this modern day of scientific development in all branches of industry, demand for efficiency, increased production, and efficient handling of material, with a minimum of cost and low maintenance, has resulted in demands upon wire rope manufacturers to keep abreast of this progress. It confronts them with the problem of producing many types of wire rope, each particular one designed for specific service, having desired physical properties. It also necessitates continued and exhaustive research in refinements in steel manufacture, wire drawing, and rope fabrication.

Wire Rope—A "Machine"

Inasmuch as wire rope is composed mainly of such a commonplace article as wire, there is an erroneous impression that wire rope is an ordinary, relatively unimportant, obscure piece of operating equipment, when compared with the general run of large, heavy, and complicated machinery found in industry. Wire rope is not often appreciated by the average user, and therefore, the full measure of efficient and economical service built into it, and maximum economy of operation, is seldom fully realized. Wire rope is a complex machine, composed of many moving parts that are designed and manufactured with precision and exactness to bear a very definite relation to one another. In fact, it has many more moving parts than many pieces of equipment classified as machines.

Usage

The oil industry is the second largest user. Both oil and natural gas wells are drilled by wire rope, and it is an indispensable tool in "bringing in" a well. Bull-dozers, angle-dozers, scraper-wagons, shovels, and draglines for clearing sites; excavating trenchers that dig ditches for oil and gas pipe lines, and water lines; pile drivers; cranes that handle structural steel and concrete, all need wire rope for their operation.

Wire rope also plays an important part in our everyday life. The constant supply of electricity, gas, water, the maintenance of our streets and roads, elevator transportation in our buildings, all of which services we consider essential, require wire rope for the operation of related machinery. In fact, the use of wire rope has become so widespread that hardly an industry can be mentioned that does not require wire rope for a variety of applications.

Wire Rope Design—Application

In the above summation of general uses it may be observed that wire rope is a tensile device. It differs from other tensile members in that it has the ability to sustain loads under conditions of repeated bending. It should possess, therefore, strength, flexibility, and fatigue resistance, and as it is a moving part of some unit, it should also possess abrasion resistance. Depending upon service conditions, these properties are required in varying degrees. Individually these properties are not difficult to obtain, but collectively they represent a complex problem because they are so related to each other that it is often impossible to accept one without some detriment to the others.

The complexity of wire usage may be better realized perhaps when it is understood that hundreds of combinations of size, grade, and construction can be supplied. Because of the great

†Presented before the Association of Iron and Steel Engineers in Cleveland on November 21 and in Youngstown, Ohio, on November 22, 1949.

*Chief Sales Engineer, American Steel and Wire Company, United States Steel Corporation Subsidiary.

variety manufactured, it should not be difficult to select a wire rope of proper size and construction, made from material suitable for service requirements, provided knowledge of qualities of ropes and conditions of usage are available. No particular benefit would be gained by enumerating all of these as many are produced for special applications. Suffice to say that, for general requirements and for simplicity and clearness in discussion, wire ropes may be divided into three major grades or strengths and three major types of construction classifications.

Grades

The first wire ropes were made of iron wire, and "iron grade" is still used for certain purposes. Subsequent industrial developments necessitated wire rope of greater tensile strengths. As a result, manufacturers produce three standard grades of steel wire for fabrication into wire rope, each differing in strength and physical characteristics, and usually referred to as: Mild plow, plow, and improved plow steel. Improved plow steel is the strongest and most wear resistant. It is about 15 per cent stronger than plow steel, which, in turn, is about 15 per cent stronger than mild plow steel. The trade names simply indicate a tensile strength per square inch minimum and maximum range, with corresponding appropriate physical properties such as: Ductility, hardness, elongation, etc. Although there are many variations, it is possible to select from these standard grades an appropriate one for almost any condition or service.

Types and Construction

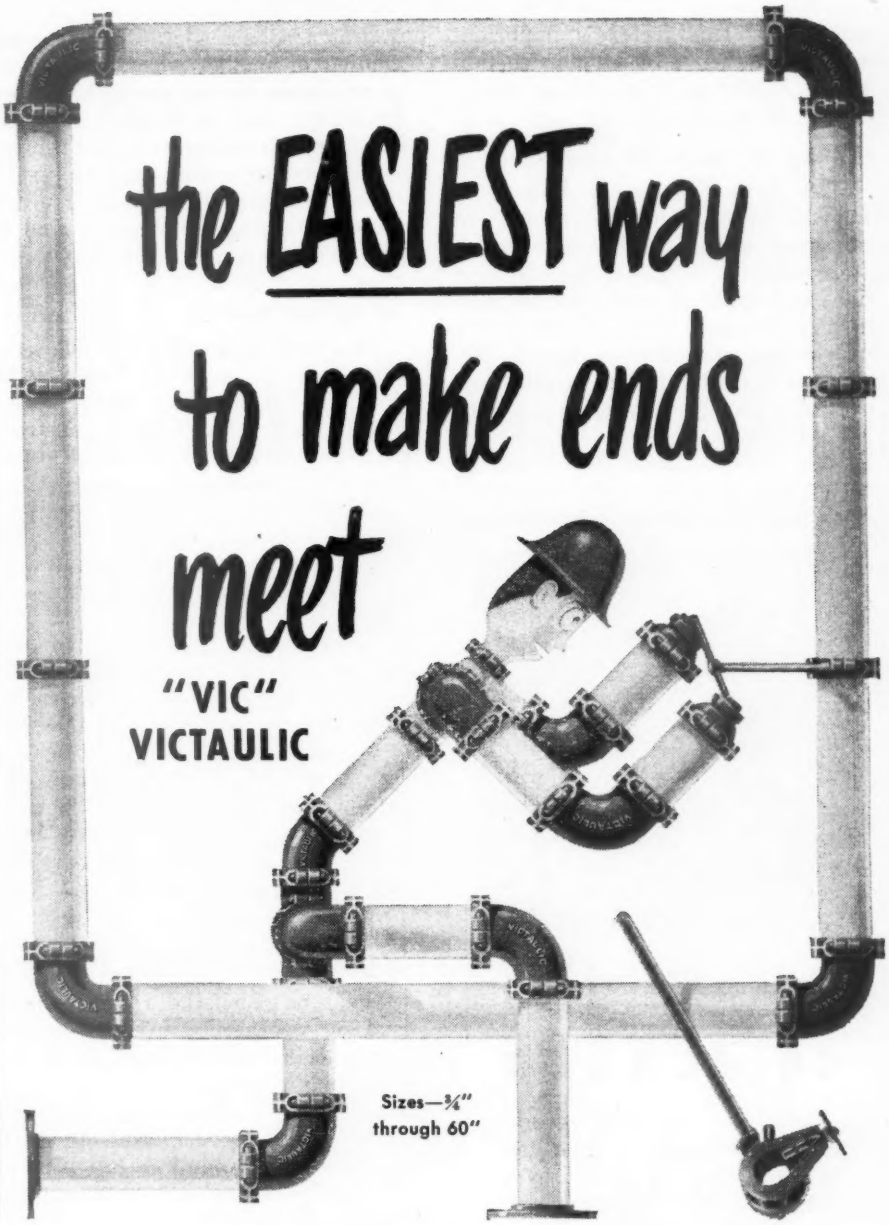
Although there are hundreds of different types of rope manufactured, all ropes fall into three general types or classifications as follows:

Group No. 1—coarse or hard laid.

Group No. 2—medium or soft laid.

Group No. 3—special or extra flexible laid.

There are two general types of wire strand construction, one having all of the outside wires of one size and the other having outside wires of unequal size, that is small and large. In any of these geometric designs, the idea is to distribute the metallic area to the best advantage, keeping in mind two factors: Areas exposed to bending fatigue and wear; and strength in reserve. This reserve strength is that percentage of the total metallic area that is protected from surface wear by the outside wires, and may be relied upon for the entire life of the rope, provided of course, that internal corrosion does



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not occur. This factor is important when choosing a rope construction where careful rope inspection cannot always be maintained.

6 by 7 Coarse or Hard Laid

This type, commonly known as haulage rope, is highly resistant to abrasion because of its large wires. It is suitable, therefore, for standing lines and applications where the rope may be dragged along the ground or over rollers and scrubbing boards. Because it is made of large wires, however, it is a stiff construction and cannot withstand the effects of repeated bending over sheaves and drums as well as a rope made up of a greater number of smaller wires. In view of its minimum reserve strength, limited flexibility, and maximum abrasion qualities, it is restricted to and is commonly used for guying derricks, smoke stacks, and towers on land, and for standing riggings on ships, as well as for numerous usages in oil fields.

6 by 19 Medium or Soft Laid

This type, generally classified as a hoisting rope, is more widely used than any other. The wires being smaller than in the 6 by 7 construction, the rope is more flexible, and can be more readily passed around sheaves and drums of moderate size. Because the component wires are finer than the 6 by 7 construction, however, it will not withstand as much abrasion as the coarser haulage or standing rope. The universal appeal of this construction can be attributed to the fact that it possesses the best balance between fatigue and abrasion resistance in the most common sizes of rope. It is used on almost every kind of modern apparatus and finds popularity in view of the average reserve strength, flexibility, and abrasion resistant properties, which are required in a great many uses of wire rope.

6 by 37 Special or Extra Flexible

This type of hoisting rope is widely used on overhead traveling cranes, and is called Crane-Rope. It is the most flexible of the six strand constructions. To obtain this flexibility, the wire must be comparatively small and numerous; therefore this rope is not suitable on installations where resistance to abrasion is a primary service requisite. Because of its high fatigue resistance, however, it is especially suitable on equipment where sheave and drum sizes are small and bending or flexing is frequent and severe. It has the greatest reserve strength and flexibility of any of the standard constructions, although its one drawback is the minimum abrasion resistance property. In this flexible category, sometimes a rope of 8 by 19 construction is made and used. This is generally for special purposes; light loading, high working load factors, which allow the use of slightly coarser outside wires. The metallic area of the rope, however, is distributed in 8 strands rather than 6 strands. This rope should not be used generally except upon consultation with the manufacturer.

Other Types

Into this classification falls a myriad of rope constructions, all offshoots of the three standard types mentioned above. In this category there are ropes and strands such as 6 by 41 shovel ropes, 18 by 7 nonspinning ropes, 6 by 12, 6 by 24 running and mooring lines, aircraft cable, sash cords, tiller ropes, locked coil track strand and smooth coil track strand, 6 by 25 type B and 6 by 30 type G flattened strand and bridge ropes. Some are common to rope usage, others are specifically designed and applied to special applications. There is one type of rope, however, that should be discussed in any paper relating to the subject. This is the type known as preformed.

Preformed Wire Rope

We previously traced the development of wire rope from early history to present day without referring to a process developed within the span of the last few years that represents a major improvement in fabrication. The process involves the pre-shaping or forming of each wire and strand to the helical position it normally assumes in the finished rope. Preforming affects the general rope structure and can be and is applied to most any grade, construction, or type of rope or strand.

Any wire rope, due to cold working of wires, twisting when stranding and laying, develops an inherent twistiness or locked up stress, similar to that existing in a clock spring when wound up, which manifests itself in devious ways. When a non-preformed rope is cut or broken it will untwist or lose its balance, which explains why seizings or bindings are necessary. As a result, such internal strain, when working with or against bending stress, and other outside factors or agencies of service, has a tendency under certain operating conditions to decrease rope life. Elimination of the internal stress and strain is accomplished by this process.

The general advantages of a preformed wire rope are many; but to name just a few, these are as follows: It is easy to handle. It requires no seizings, and will not fly apart when cut or broken in service, retaining its balance. It normally resists kinking because of its freedom from liveliness and twistiness. It does not have a tendency to rotate in grooves. It is easy to splice, and normally, winds smoothly and evenly on drums. In short, preformed wire rope, because it is free of internal stresses, has complete freedom of action under tension and bending and, therefore, each component part can adjust itself to various conditions and carry its share of the load.

In comparison to a non-preformed

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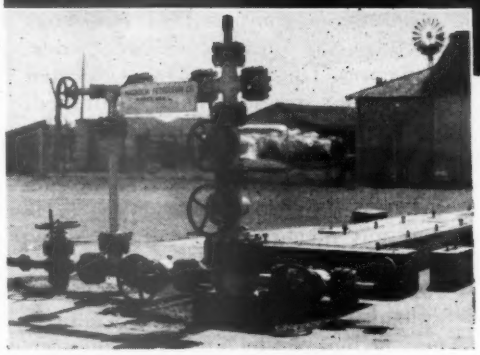
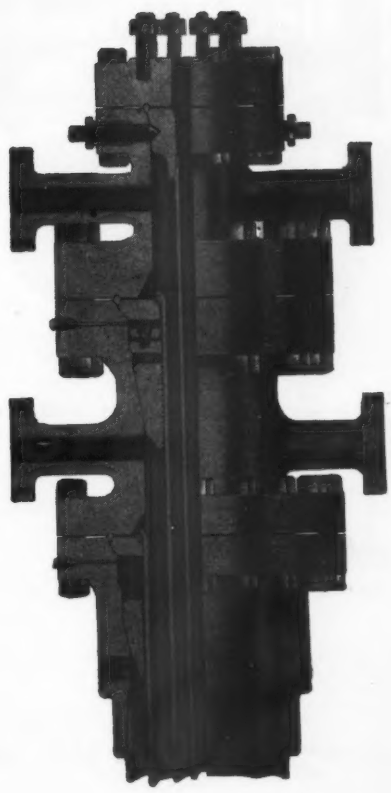


RECTORHEAD ASSEMBLY AS USED ON HANEY NO. 2

The hook-up of Rectorhead illustrated at right is the same as that on the Haney No. 2 well. It consists of a 13⅜" OD 8 round thread x 8⅝" OD type 6RH, 4000# Test RECTORHEAD on bottom. The intermediate head is a nom. 12"-600 by 10"-900 Type 9RH 6000# Test, RECTORHEAD, suspending 5½" casing. The tubing head is a nominal 10" by nominal 6" type 9M 6000# Test RECTORHEAD suspending 2" EUE tubing. NOTICE THERE IS NO RESILIENT PACKING OR SOFT SEAL IN EITHER CASING HEADS OR TUBING HEADS.



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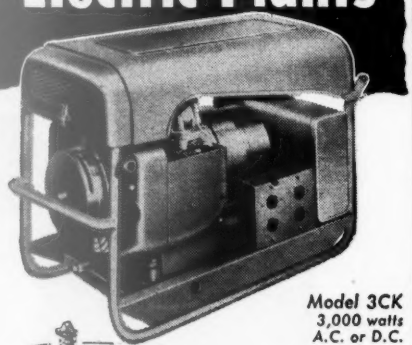

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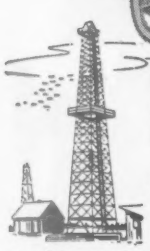

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rope, it is equally as strong, equally or slightly more flexible, equal in crushing, wear, and corrosion resistance, but has a much higher resistance to fatigue caused by bending. It can, however, be equally abused by the user, and requires the same care and maintenance to prevent loss of efficiency and resultant poor service. It is not a fool-proof rope in the strict sense of the term. Its only disadvantage lies chiefly in the fact that by virtue of the inertness of the individual wires it requires, normally, a closer visual inspection to determine the condition of the rope. Broken wires are not as easily detected because, when worn or parted, the rope does not "porcupine," that is, does not protrude as in a non-preformed rope. Throughout the years of its use, however, experience has indicated no particular hardship or inability to evaluate the condition of rope from a broken wire standpoint. A preformed rope, is a safer rope to handle when worn, because broken wires will not protrude and injure workmen's hands.

Wire Rope—Care and Maintenance

Machinery of any kind requires proper care and attention to obtain satisfactory operation. Wire rope, considered a complex and intricate machine, is composed of numerous parts in the form of wires, strands, and cores. These parts when subjected to loads or stresses engage in limited, yet positive, movement. Thus, the proper use, care and maintenance of wire rope is just as important to service, performance and economy, as it is to any machinery. Yet it is not uncommon to see a reel or coil of wire rope delivered to a user, carelessly unloaded almost any place, where it may be bumped by a truck or run over by a tractor. Then, when the rope is put into use, it is promptly forgotten, neglected, and abused. Abuses of many kinds must be guarded against, and neglectful maintenance eliminated, if satisfactory performance is to be obtained. The correct handling of wire rope, both before and during its use, is very essential, if best performance and economy are to be obtained.

Wire Rope—Care

Reels of wire rope should not be dropped from cars or trucks, as the weight of the rope might collapse the drums on which it is wound. This might cause rope to cut in, and it is very difficult to unreel the rope without severely damaging it. When using a bar to roll a reel of wire rope, the user should pry against the reel head, not the rope. When removing wire rope from the reel on which it was received, or from a coil, it is important that the reel or coil rotate as the rope unwinds. Attempts to unwind wire rope from stationary coils or reels will result in kinking a rope, and once a kink is formed, the rope at that point is ruined beyond repair. When a shipment of wire rope is not to be immediately put into service, it should be stored in a dry place away from acid or corrosive fumes and protected from the weather. The manufacturer takes every precaution when shipping in cars, so why not the user?

When cutting wire rope from a reel prior to installing, take pains to seize or bind the ends no matter what kind of a rope it is. Seizings or binds, as they are sometimes called, are required to prevent the untwisting of wire ropes and are applied to both sides of the point where it is to be cut. Seizings that do not preserve the rope structure, but permit the strands to untwist, result in shortened service because of the unbalanced condition of the rope. Avoid kinks during installation by proper and careful handling. A kink in wire rope, no matter how developed, will greatly reduce the life of the rope. Do not allow the rope to form a small loop. Should a loop form, however, remove it before it is pulled down, otherwise the rope is apt to be damaged permanently. It is of little value in this condition as the strands and wires, being damaged, will break up very quickly at this point, often resulting in sudden breakage. No matter how well a kink may appear to be straightened, the rope is definitely weakened at that point.

After a wire rope is installed, it is advisable always to run the new wire rope with a light load or with no load for a short period of time. This "breaking-in" process gives the component parts of the rope an opportunity to adjust themselves to the conditions under which the rope is to operate. The time spent in breaking-in a wire rope will pay dividends in extra useful rope life. During use avoid, if possible, overwinding and crosswinding. It is not good practice to have more than one layer of rope on a drum. If this cannot be avoided, the succeeding layers should not crosswind, but should wind regularly in the groove that is formed by the preceding layer of wire rope. Crosswinding is an extremely bad practice. This type of abuse causes more damage to wire rope than most users realize.

Avoid overloading and shock loads. Although rupture does not take place, the elastic limit of the rope may be exceeded with permanent distortion resulting. Sudden stresses caused by

jerking a wire rope may exceed the strength of the rope and break it. Jerks that do not break the rope may cause rapid deterioration and shorten rope life. When picking up or moving a load these sudden stresses may equal a value several times the weight of load lifted. Loads should always be applied gradually and the rate of acceleration should be kept as uniform as possible, keeping within the designed factor of safety (ratio of strength of rope to working load) to minimize these dangers.

Generally speaking, it is not possible for the wire rope manufacturer to set proper safety factors for all the various types of wire-rope-using equipment. This factor can and does vary with individual equipment, depending not only on the loads applied, but on the speed of operation, the acceleration and deceleration, the length of rope, the size of sheaves and drums, the conditions causing abrasion and corrosion, and the facilities for inspection. There are published guides of suitable minimum safety factors that have been established by experience as required on the average installation. The largest possible safety factor is desirable, however, as it represents, in most cases, increased economy and greater safety of operation.

All operating wire ropes are subjected to bending around sheaves or drums during normal operations. Service obtained from wire ropes is, to a large extent, dependent upon the proper choice of size and location of the sheaves and drums. Wherever possible, therefore, wire rope should be operated over sheaves and drums of the largest permissible diameter. The fatigue effects of bending are manifested by the tendency of the wires in the wire rope to break square off, and small sheaves and drums will cause a permanent set in a heavily loaded rope. Experience has established the fact that from a service viewpoint, a very definite relationship exists between the size of the wire rope and the size of the sheave or drum about which it operates.

It is impossible to give a definite minimum size of sheave or drum about which a wire rope will operate with satisfactory results, because of the other factors affecting the useful life. If the loads are light or the speed slow, smaller sheaves and drums can be used without causing early fatigue of the wires. Reverse bends, where a rope is bent in one direction and then in the opposite direction, cause excessive fatigue and should be avoided whenever possible. When a reverse bend is necessary, larger sheaves are required, and should be spaced a sufficient distance apart to allow component parts to adjust to normal position before bending in another direction.

Although catalogues and engineering handbooks show the minimum tread diameters of sheaves and drums for use with the various sizes, grades and constructions of wire rope, it should be understood clearly that these are the minimum sizes that, under favorable operating conditions, are permissible and that only reasonable rope service can be expected. If the features of operation such as speeds and loads, are severe, larger sheaves and drums should be used. The amount by which they should exceed these minimum figures depends upon the severity of the conditions of service. Experience has shown that the use of larger sheaves and drums will result in increased wire rope service, which will usually more than warrant the additional cost.

Wire Rope—Maintenance

Of the many forms of wire rope abuse, with its attendant loss of efficiency and economy, the following are a few major ones due to neglected or faulty maintenance: Wire ropes are

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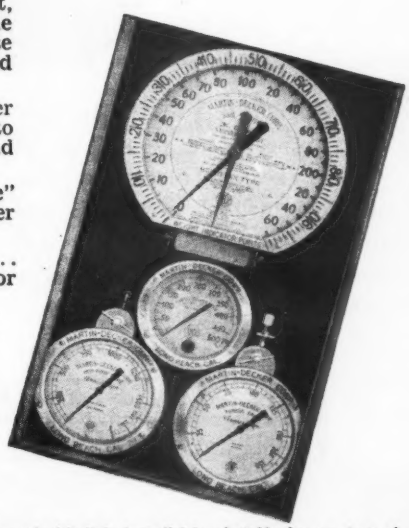
THE CLIPPER "SEALTITE" Weight Indicator and Drilling Control Instrument provides the driller with information on all of the important drilling factors—not just weight alone.

An instrument which reliably shows weight, mud pressure, torque and rotary table speed, assembled in a small compact case for jackknife derricks, folding masts and derricks with limited floor space.

It has all the flexibility of a Toolpusher Model but the gauge is not subjected to the violent whip and vibration of the dead line.

You can install or move a Clipper "Sealtite" just as quickly and easily as a Toolpusher type and it will last much longer.

Made in a wide variety of combinations . . . there is a Clipper "Sealtite" available for every purpose.



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- IT'S SENSITIVE
- IT'S COMPACT AND COMPLETE
- IT'S MODERN
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- IT'S SEALED

The Clipper "Sealtite" is immediately adaptable for any type of rig, large or small.

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not properly lubricated; are allowed to drag over obstacles; are operated over tight, scored, and fluted sheave and drum grooves, and are operated over sheaves and drums out of alignment. There are a number of maintenance practices that will result in greater efficiency and economy from wire rope. These are: Reversing ends; cutting back; lubricating regularly, and periodic inspection.

Wire ropes are lubricated properly during fabrication and go to the user ready for service. This initial lubrication, no matter how efficient, is not sufficient, however, to last the life of the wire rope. Periodical field application of a good grade of oil or grease is essential. The lubricant should be free from acids and alkalies; should have sufficient adhesive strength to stay on the rope; should be able to penetrate between the wires and strands; should be non-soluble under the conditions prevailing where the rope operates; should have a high film strength; and should resist oxidation.

Operating or used ropes should be cleaned before they are re-lubricated. The cleannig may be accomplished by means of wire brushes or scrapers, or by compressed air or superheated steam. The object is to remove all foreign material and old lubricant from the valleys between the strands and from the spaces between the outer wires. The lubricant may be applied then in any manner suitable to field conditions. It may be brushed onto the rope with a stiff brush; applied by passing the rope through saturated waste or through a trough or box of lubricant; or the lubricant may drip onto the rope, preferably at a point where the rope opens slightly from bending. The object, in any case, is to apply a uniform coating to the entire length of rope. If possible, wire rope on idle equipment should be cleaned, lubricated, wound on a reel, and stored. If removal is not possible or practical the rope should be cleaned and lubricated in its entire length for protection against corrosion.

Wire ropes are frequently allowed to drag over obstacles resulting in unnecessary wear and abuse. The use of supporting sheaves and rollers decreases the wear on the rope and results in increased service. Sheaves and rollers should have grooves sufficiently large to prevent pinching of the rope. All sheaves and rollers should be remachined or replaced, when scored by the rope, to prevent unnecessary wear on the outer wires of the rope. These sheaves and rollers should be free to rotate, large enough in diameter to avoid unnecessary bending, provide adequate support, and be light enough

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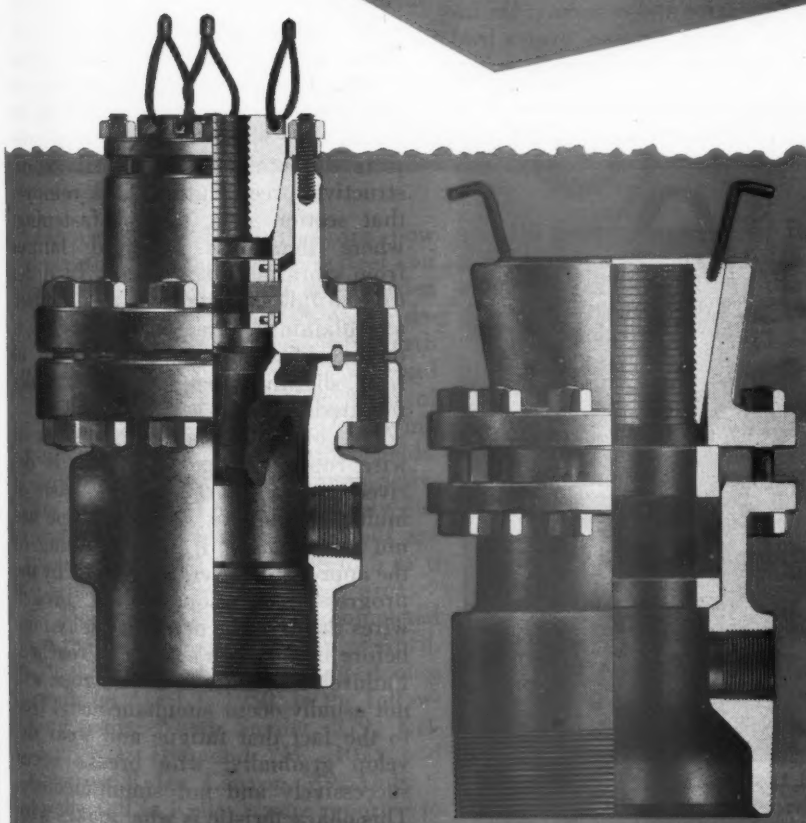
with greater flexibility than any other low pressure hook-up



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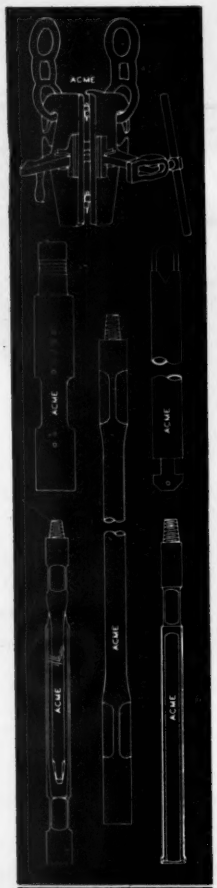

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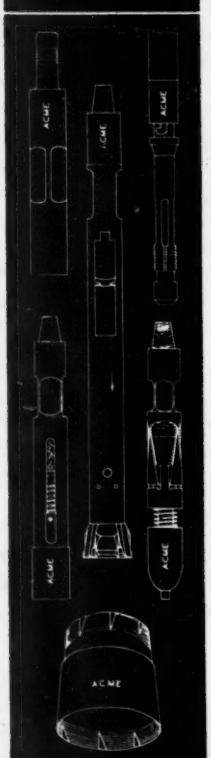

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in weight to start and stop readily as the rope starts and stops. Heavy sheaves and rollers build up momentum when turning. This causes slippage when the rope stops. They are slow to pick up speed when the rope starts. This produces additional slippage which in turn produces abrasion.

Proper maintenance will not neglect sheaves—they are of prime importance in prolonging rope life. Sheaves should be of ample diameter to prevent excessive bending stresses and should fit the rope. Narrow grooves may pinch and distort the rope causing wear, internal stress, and friction. Wide grooves may cause the rope to flatten from lack of support. Worn sheaves prevent proper seating and will cause trouble with the best wire rope. Sheaves should also be aligned so that the axis of the rope is parallel to a line drawn from the center of the groove of one sheave to the center of the groove of the next sheave. This prevents excessive wear on the rope caused by its bearing against the flanges or dragging across the shoulders.

Wire ropes operating over sheaves and drums out of alignment are detrimental to service and economy. On installations where it passes over a lead sheave, then onto the drum, it is important that the lead sheave be situated at a sufficient distance from the drum to maintain a small fleet angle at all times. The "fleet angle" is the side angle at which the rope approaches the sheave from the drum. It is the angle between the center line of the sheave and the wire rope. Experience has proved that the best wire rope service is obtained when the maximum fleet angle is not more than one and one-half degrees. A one and one-half degree angle is the equivalent of about 40 ft of lead for each foot of rope traverse travel either side of the center line of the sheave. Thus a drum with a 3-ft traverse travel, with the center of the travel in line with the lead sheave, should be situated about 60 ft from the lead sheave.

A rope is usually changed end for end to distribute the wear and fatigue resulting from bending and vibration. If these destructive forces are uniform throughout the system, no economy is effected by such a change. On most installations, however, these forces are more severe for one-half of the rope than for the other half, and reversing the ends increases the rope service. The object of cutting short lengths of rope from the drum or fastened end, is to change the position of the rope. Wear and fatigue are usually most severe at certain definite points on wire-rope-using equipment, and the removal of a short length of rope subjects different portions to these destructive forces. Cutting back removes that section next to end fastenings where maximum localized fatigue from vibration often occurs. In order to take full advantage of this method of obtaining increased service, it is often advisable to use a length of rope slightly longer than normally required.

One of the outstanding features of wire rope as a tensile device is derived from the fact that it consists of multiple members. If a wire rope has not been abused, it gives warning of the approach of eventual failure by the progressive development of broken wires that may be detected easily long before its ultimate service is reached. Failure of all units in a wire rope will not usually occur simultaneously. Due to the fact that fatigue and wear develop gradually, wire breaks occur successively and not simultaneously. This characteristic is what makes wire rope the most dependable tensile mechanism that is available for hauling, hoisting, conveying, supporting, and strengthening.

It is an efficient machine and tool—make good use of it—take care of it—maintain it in proper working order—and it will give you long, efficient, and economical service. * * *

Photo courtesy The Lincoln Electric Company.

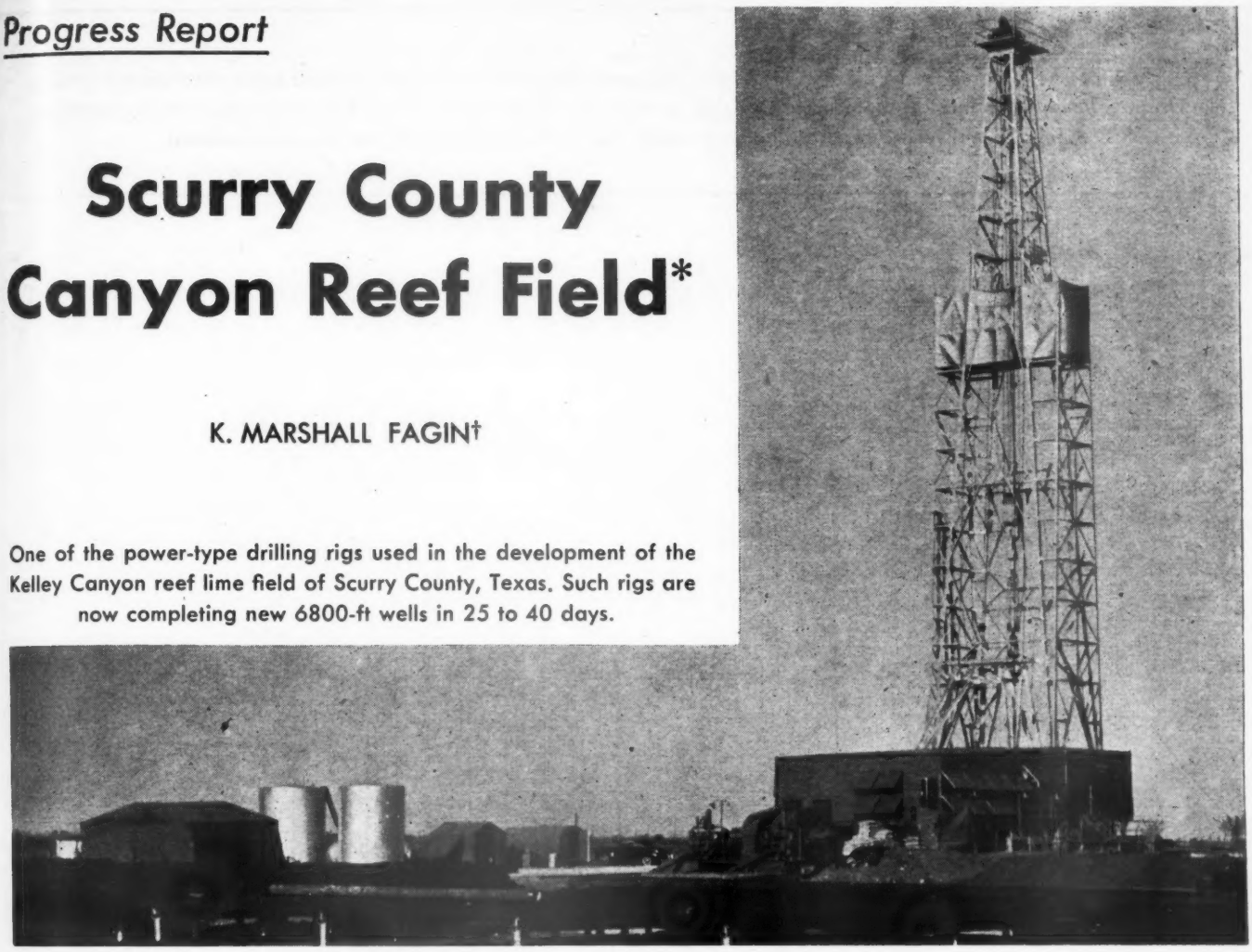
Mud Pump Valve Cover

Made from a piece of discarded drill pipe, and painted a glowing orange color, this cover protects drilling crew from flying particles of sheared pin if pressure valve lets go on the mud pump. The half circle handle is welded in place to facilitate carrying of unit.

Progress Report

Scurry County Canyon Reef Field*

K. MARSHALL FAGIN†



One of the power-type drilling rigs used in the development of the Kelley Canyon reef lime field of Scurry County, Texas. Such rigs are now completing new 6800-ft wells in 25 to 40 days.

ABOUT 200 drilling rigs are now operating in the Canyon Reef oil fields of Scurry, Kent, and Borden Counties, Texas. The bulk of the development drilling activity is in North Snyder, Kelley, Diamond "M," and the Sharon Ridge Canyon fields of Scurry County. More rigs are moving into the newer Kent County fields, however, as the Scurry County activity eases off and the Kent County discoveries are extended. New wells are being completed at the rate of 5 or 6 per day in the Scurry County area.

More than 700 wells were completed in the main fields by the end of April, 1950, compared with 584 producing wells on April 1, 1950, in the following fields: North Snyder, 279; Kelley, 159; Diamond "M" 107; and Sharon Ridge Canyon, 39. Only 7 wells (all in Kelley) were reported to be pumping or on artificial lift, although pumping units are already installed on a few more. Twelve wells were reported to be producing some water with the oil. The location of these wells is indicated on Fig. 1.

Oil production from the four main fields reached a peak of 1,513,125 bbl, or 54,000 bbl daily, during February, 1950, and dropped to about 1,063,600 bbl, or 34,500 bbl daily, during March, 1950 due to a sharp reduction in allowable. The allowable is now about 90 bbl per well per calendar day. Gas production was about 1,316,419,000 cu ft in February and 925,332,000 cu ft in March, based on the average solution gas-oil ratio of 870 cu ft per bbl at separator conditions of 20 psi and 70 F. Water production for February was about 7743 bbl, or 285 bbl daily, and for March about 17,600 bbl, or 570 bbl daily, according to test data submitted by the operators.

Cumulative oil production from the four main fields was about 8,133,976 bbl on March 1, 1950. North Snyder was credited with 4,827,130 bbl; Kelley with 1,313,828; Diamond "M" with 1,425,077; and Sharon Ridge with 567,941 bbl.

Daily average oil production in February by fields was: North Snyder, 27,300; Kelley, 12,700; Diamond "M," 10,300; and Sharon Ridge, 3700 bbl. The daily production in March, 1950 was: North Snyder, 16,800; Kelley, 8800; Diamond "M," 6500; and Sharon Ridge, 2400 bbl.

The original bottomhole pressure in all fields was 3122 psig at —4300 ft (subsea). The last survey, which was made after the fields were shut-in for an 8-day period, showed the average bottomhole pressures had declined as follows on April 1, 1950: North Snyder down 322 psig to 2800 psig; Kelley down 132 psig to 2990 psig; Diamond "M" down 562 psig to 2560 psig; and Sharon Ridge down 217 psig to 2905 psig.

The bubble point as determined from some 10 reservoir fluid samples ranged from 1725 to 1950 psig in the four fields. Core analysis measurements on some 6000 samples indicated that the average porosity of the reef limestone averaged from 5.13 per cent in Diamond "M" to 8.6 per cent in North Snyder.

The porosity of individual samples ranged from 2.2 to 21 per cent. The average porosity of the effective pay is estimated to be about 12 to 14 per cent. * * *

*See "Economics of Scurry County Fields," by K. Marshall Fagin in the January, 1950, issue, page 1[illegible].

†Editor, Exploration, Drilling and Production of *The Petroleum Engineer*.

EXCLUSIVE

FIG. 1. The Scurry County Canyon Reef Oil Fields—All producing wells (indicated by solid black dots) where flowing in North Snyder, Diamond "M," and Sharon Ridge on April 1, 1950. Eight wells in Kelley are shown to be pumping. Only 12 wells were reported making water. The well in section 340 has been abandoned.

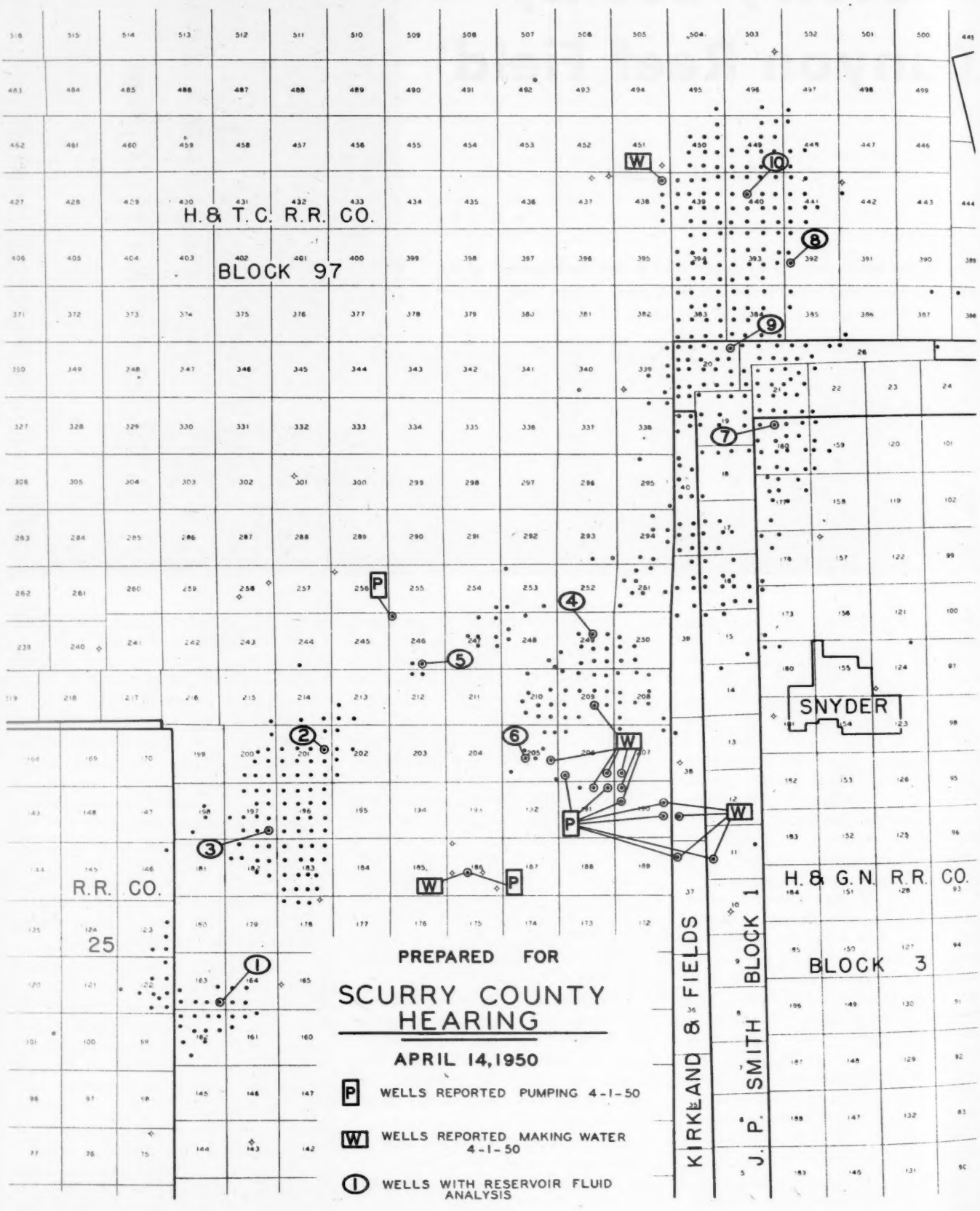
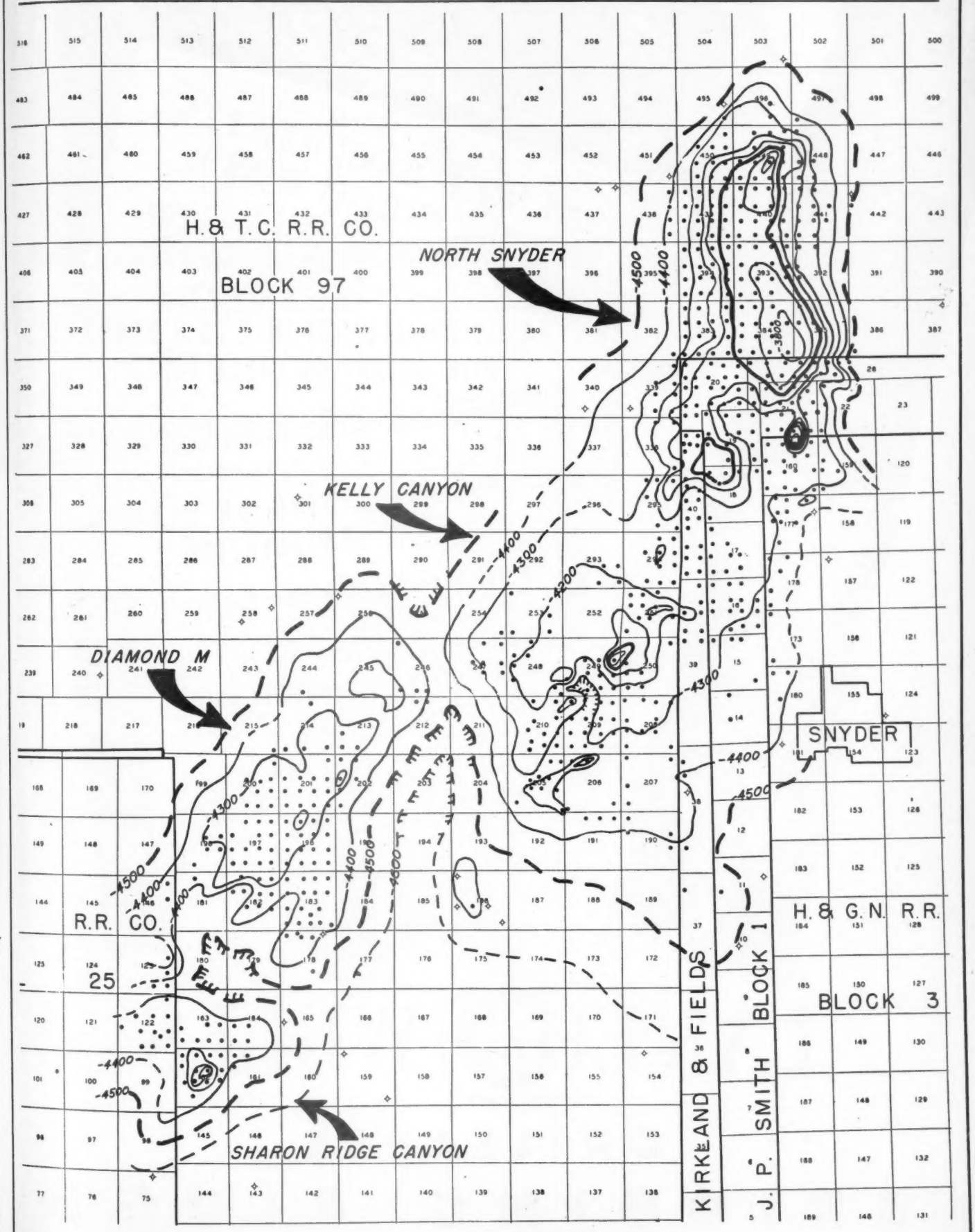


FIG. 2. Structure map of Scurry County Canyon Reef limestone—100-ft contours indicate the 700-ft build-up of the reef in the North Snyder field. Water level is irregular although generally determined near — 4500 ft subsea.



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AIME Studies Core Analysis and Completion

Interpretation of core analysis and well completion was discussed at a recent meeting of the junior section of the Pacific petroleum chapter of American Institute of Mining and Metallurgical Engineers.

The speaker, Dr. Norris Johnston* emphasized that assisting the intelligent approach to well completion is only one of the many important uses of core analysis. He reserved for possible future discussions its application to reserve estimation and unit plans.

In the completion application, the major objective is quick utilization of the core to determine whether or not the well will produce water, oil or gas; not so important are the quantities of each that may be produced. The major contribution of core analysis is, therefore, in the determination of saturation and the presence of oil and gas productive sands. Permeability and porosity, grain analysis and consolidation for liner design and correlating with electric log interpretation are the other major uses of core analysis in this application.

In the attempt to define reservoir conditions from core saturation, a major problem arises from the difference that exists between the core as received in the laboratory and as it existed prior to entering the core barrel. One of the important factors contributing to this difference is the type of drilling fluid employed. There may be as much as 150 per cent water contamination of a core due to the efflux of water in the drilling fluid ahead of the bit and radially outward into the formation.

Core analysis can be of valuable assistance in the interpretation of electric logs, especially in the distinction of oil and fresh water sands and oil productive and gas productive formations. Johnston pointed out that formations that indicate oil saturations on an electric log can be wet due to salinity differences, which can only be determined by core analysis.

Completion effectiveness (the behavior of a well compared to its theoretical attributes) can also be aided by core analysis by acquiring knowledge about a formation through coring prior to a well's completion. Well treatments with acid, chemical washes, mud cake removal practices, and surface tension control may aid in obtaining a good completion. No one method is best in every case, however, and often, if the well exhibits poor productivity, excess remedial efforts will not correct the situation and it may become necessary to redrill.

*Head of Petroleum Technologists, Inc., of Montebello, California.

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Otis Pressure Control, Inc.

NEWS

Stripper Well Reserves Subject of Meeting

Technical studies of the nation's stripper well oil reserves and secondary recovery methods were reviewed by the National Stripper Well Association in Los Angeles, California recently.

A report was submitted by the association's secondary recovery and stripper well survey committee headed by R. C. Earlougher, petroleum engineer of Tulsa, Oklahoma. A national depletion committee also reported at the meeting, and approval of additional committees was made.

The Stripper Well Association is a national technical organization closely allied with IPAA, Interstate Oil Compact Commission and other industry groups to keep tab on the nation's stripper well reserves and determine their effects on oil industry economics.

Officers of NSWA are J. P. Jones, president; V. C. Perini, Jr., Abilene, Texas, and M. G. Powers, Huntington, West Virginia, vice presidents, and G. Gerald Bauer, Bradford, Pennsylvania, secretary-treasurer.

Production in Saudi Arabia Dips 12 Per Cent in 3 Months

Crude oil production in Saudi Arabia during March amounted to 12,757,608 bbl, or an average of 411,536 bbl per calendar day, it was announced by the Arabian American Oil Company. March production was down 17.1 per cent from the preceding month, the company reported.

Crude oil production for the first three months of 1950 amounted to 40,605,823 bbl, an average of 451,176 bbl per calendar day compared with 46,328,665 bbl in the first three months last year.

Elk Hills Plans Cut Back

The number of drilling rigs operating in the Naval Petroleum Reserve No. 1 at Elk Hills will be reduced from seven to five, Com. William G. Greenman, director of naval petroleum reserves, told the House Appropriations Committee recently.

Greenman said that government operations in the reserve will pay their own way from the Navy's share of the oil produced under the unit contract with Standard Oil Company of California.

Originally the Navy's engineering advisers outlined a plan for drilling 350 wells at a cost of $80,000,000 over a period of 10 to 12 years with continuous operation of seven rigs, he said, but more recent studies indicate that as many as 867 wells may be necessary ultimately. Estimated recoverable reserves at Elk Hills total 700,000,000 bbl and the field is expected to produce a maximum of 215,000 bbl per day when fully developed.

AAPG Holds Annual Meeting

The 35th annual meeting of the American Association of Petroleum Geologists was held in Chicago, Illinois last month. Devoted to scientific and technical papers and discussions, the meeting was held jointly with the Society of Economic Paleontologists and Mineralogists and the Society of Exploration Geophysicists.

Speakers included representatives from the United States, Japan, the Netherlands, Mexico, Venezuela, and Canada.

Colon Venezuelan Output Up

The Colon Development Company, Ltd. produced 393,055 bbl of crude oil in Venezuela for the five weeks ending April 3. This amount tops February's total of 332,115 bbl, in the four weeks ending February 27.

Form New Geophysical Firm

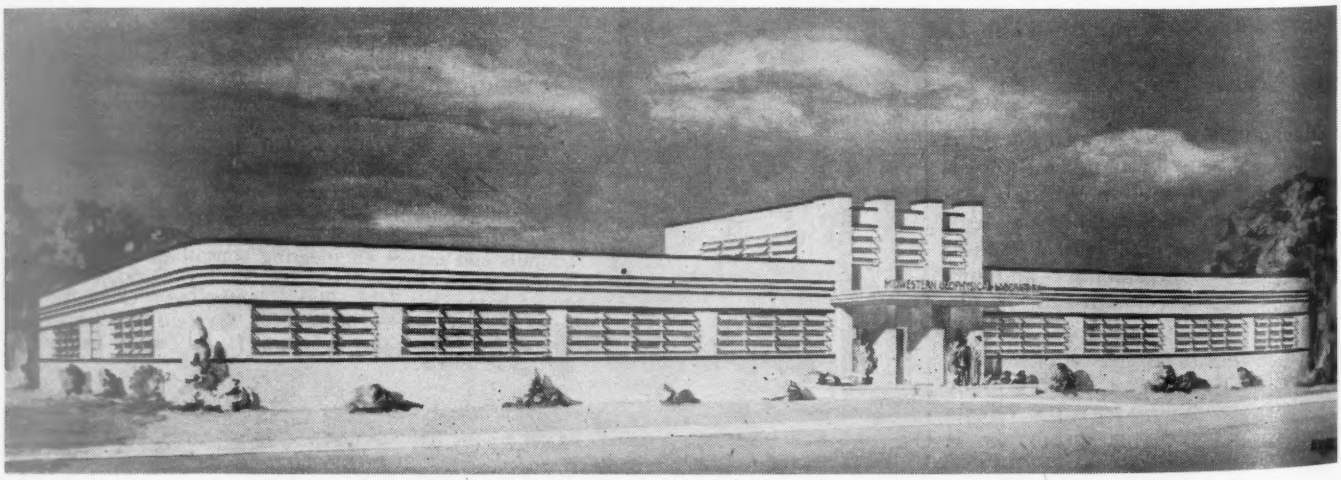
A new firm, Midwestern Geophysical Laboratory, has been announced for Tulsa, Oklahoma by E. Jack Handley and M. E. Morrow, both well-known in the seismic exploration and manufacturing business. The

E. Jack Handley M. E. Morrow

new company is now doing business from its Red Fork location, 2803 West 40th Street, Tulsa. In addition to field crews for contract seismic work, the laboratory will employ more than 100 technicians and craftsmen before the end of this year.

Morrow, president, has long been active in the geophysical business. His first undertaking in the geophysical field was with Humble Oil and Refining Company in the geophysical laboratory in 1930. He was subsequently employed by Carter Oil Company geophysical laboratory, and Engineering Laboratories, Inc.

Handley, executive vice president, is a graduate of Oklahoma University. He began his first geophysical work in 1934, and has worked for Continental Oil Company, British-American, Shell Oil, and Century Geophysical Corporation. G. R. (Bob) Morrow, in charge of manufacturing operations, attended Oklahoma A&M and has done post graduate work at Johns Hopkins University. He was formerly with Century Geophysical Corporation.



Midwestern Geophysical Laboratory building, Tulsa, headquarters of new firm.

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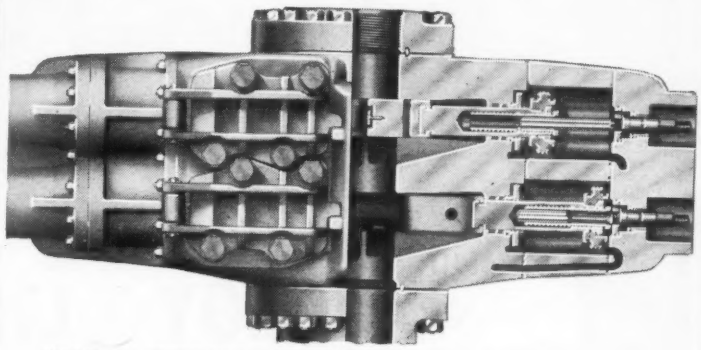
Regardless of your pressure control requirements, there's a Shaffer product to fill them . . . *Hydraulic* Cellar Control Gates . . . *Mechanical* Cellar Control Gates (both *Single* and *Double*) . . . Combination Rotating Blowout Preventers and Strippers . . . a complete line of advanced Casing and Landing Heads . . . various types of Tubing Heads, Flow Beans and other equipment for *every* pressure control requirement. The unusually diversified line of Shaffer field-tested equipment includes . . .



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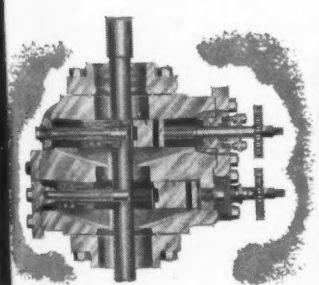
- Even in sizes as large as 13⅜" you get *two* ram compartments in an overall height of only 30"—*smaller sizes even less!*
- Completely enclosed—no outside moving parts to become damaged or corroded by chemical muds dripping into cellar.
- New simplicity in changing rams—simply unbolt and open two doors, change rams, then close and bolt the doors. A new high in simplicity, speed, convenience!

The above are only a few of the *many* far-reaching advancements designed into the new Shaffer Hydraulic Cellar Control Gate. Available in a full range of sizes and pressure ratings. Write for full details!



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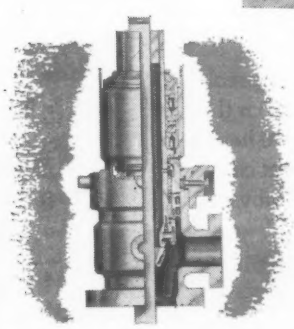
- Rams are quickly changed by simply removing one end cover—an easy, simple operation.

Shaffer Double Cellar Control Gates also provide many other unique features and are available in a full range of sizes and pressure ratings to meet any requirement.

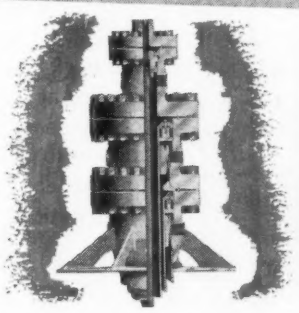
For applications where maximum conservation of vertical space is not essential, Shaffer also features a complete line of mechanically operated *single* Cellar Control Gates.



Shaffer Combination Rotating Blowout Preventer and Stripper—combines in *one* unit every necessary feature for complete and fool-proof pressure control while drilling under pressure . .

- Maintains continuous seal around all elements in the drill string—square, hexagonal, octagonal or round—rotating or not.
- Automatically expands and contracts to fit varying diameters in the string such as tool joints, couplings and drill collars.
- Not only maintains its seal while the drill string is rotating, but also while stripping pipe in or out of the well.
- Quick-Releasing Bonnet permits passing abnormally large tools such as bits and reamers through the unit quickly and conveniently.

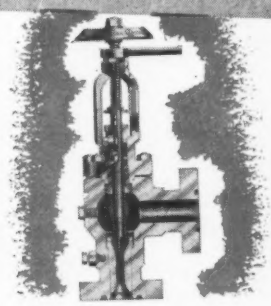
There is nothing as *complete*, as *advanced*, as *simple* as this Shaffer unit for maintaining complete pressure control while the drill string is rotating or being stripped in or out of the well!



Shaffer Landing, Casing and Tubing Heads—used in all major oil producing countries throughout the world for modern compact casing or tubing suspensions.

- Available in many types and various packing arrangements, including types where no internal threads are used for holding packing element in place.
- For maximum compactness, Base Heads and Combination Base, Casing and Tubing Heads are available that combine several units in one.

From Shaffer you can also obtain a full line of advanced Tubing Heads, Multiple Zone Hook-Ups and other equipment to complete your pressure control installation.



Shaffer Adjustable Flow Beans—provide means for controlling the flow of fluid under pressure. Shaffer pioneered Adjustable Flow Beans and offers a wide range of different types for drilling, production and refinery operations—all embodying unique advancements found nowhere else. Shaffer Adjustable Flow Beans are available with Conical, Micro and electrically-heated Thermo Tips in both regular and hard metal designs. All popular sizes—both flanged and screwed connections to meet any installation requirement.

Write for the new Shaffer Catalog that describes Shaffer products in greater detail!

See pages 4433 to 4496 of the 1950 Composite Catalog.

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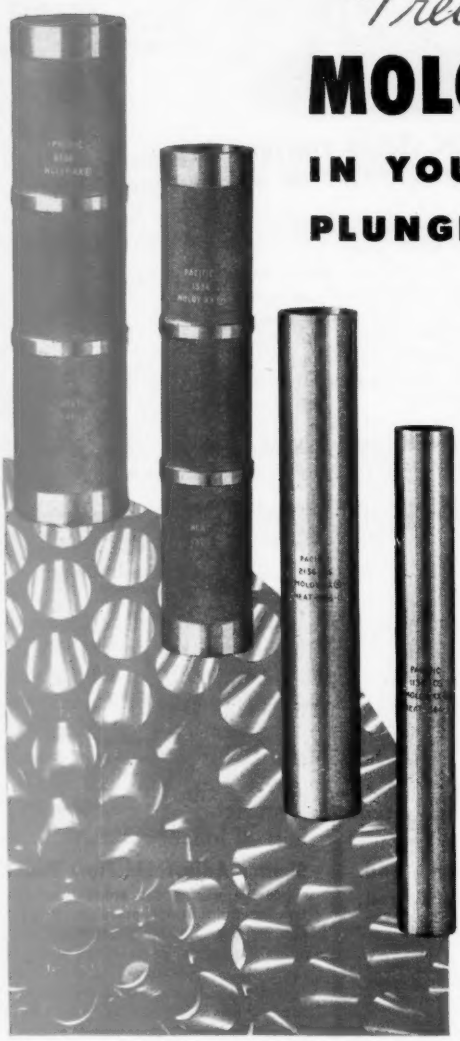
Pacific

Precision Built

MOLOY ® LINERS

IN YOUR OIL WELL PLUNGER PUMPS



MOLOY—® a ferrous alloy developed by Pacific primarily for oil well plunger pump liners has all the qualities for long economical life in your well. Strength, toughness, hardness combined, give MOLOY greater resistance to temperature, corrosion and abrasion than ordinary iron liners.

MOLOY—® LINERS are precision controlled at every step from the electric furnace to the final heat treatment to insure perfect castings of uniform chemical and physical characteristics.

MOLOY—® LINERS are precision finished to extremely narrow tolerances. You receive the full benefit of this precision finish because the uniform structure and, above all, the stability of MOLOY ® prevents the liners from warping after machining operations are completed.

IN FIELD AFTER FIELD, THE STRENGTH AND DURABILITY OF MOLOY—® LINERS HAS REDUCED PRODUCTION COSTS AS MUCH AS 50%

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AAODC Holds Annual Management Institutes

Plans for the Second Annual Management Institutes for the drilling industry have been announced by the American Association of Oilwell Drilling Contractors, with meetings tentatively scheduled to be held in 15 centers throughout the country during May and June, 1950.

To be conducted by the University of Texas division of extension, and supervised by the Association's educational administrative committee, the new series of conferences will be held on two consecutive days in each of the 15 centers.

Institute 1 will be on "Insurance Problems in Oilwell Drilling" and will be conducted by James H. "Jim" Johnson, who, for 23 years prior to his retirement in 1949, was insurance manager for Continental Oil Company and its predecessor, Marland Oil Company. Since retirement, he has been on special assignment with Cit-Con Oil Company as insurance consultant.

C. W. "Dee" DeLancey, who, prior to his retirement in 1949, was manager of drilling and production for Gulf Coast division of Humble Oil and Refining Company in Houston, will lead Institute 2 on "Drilling Contractor-Oil Company Relationship." Some of the problems to be covered include: Clarification of the request for bids; clarification of the contract terms; establishment of an understanding of each party's responsibilities, etc.

Oil Well Restoration Program at Long Beach

An oil well restoration program for the first half of 1950 amounting to $1,440,000 was approved by the Long Beach Harbor Commission, after chief petroleum engineer M. D. Hughes of the Harbor Department recommended steps that must be taken to restore the Terminal Island wells damaged by the earthquake in November.

About 24 wells should be redrilled within the next six months, Hughes said, but a two-year program is contemplated for restoring the 135 wells that were damaged.

Hughes said that 60 per cent of the department's oil production from Parcel W was cut off by the earth slippage which crushed casings. He estimated the department's loss at $480,000 monthly from disablement of the 135 wells; loss from damaged wells still producing at $120,000 monthly, and loss from inadequate development $100,000.

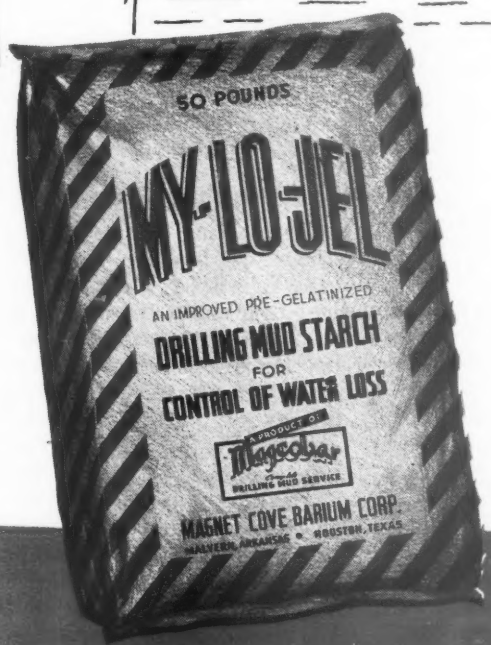
RECORDS FROM THE FIELD PROVE:

My-Lo-Jel has lowered mud costs as much as 20%

MY-LO-JEL . . . AN UNMODIFIED BLENDED STARCH . . . HOLDS WATER LOSS DOWN LONGER BECAUSE ITS PURITY PRODUCES A FAR TOUGHER STARCH

Magcobar My-Lo-Jel is an improved pregelatinized drilling mud starch in the form of a free flowing powder which can be added directly to the mud through a hopper mixer. My-Lo-Jel provides positive control of the filtration properties even in the presence of salt, anhydrite and other contaminants. It is a blended starch . . . blended from premium type corn . . . that is especially processed to produce a quick acting, tough and chemically stable plugging agent to inhibit filtration of mud. Thus, it not only lowers water loss, but keeps it low.

My-Lo-Jel is easy and economical to use . . . and you pay no premium for Magcobar's premium quality drilling mud starch. So look for the Magcobar dealer sign when you need mud. There are more than 250 Magcobar dealers strategically located throughout the oilfields to give you immediate delivery of My-Lo-Jel and other dependable drilling muds and chemicals.



My-Lo-Jel can take the place of protective strings! So why take chances with tight holes due to filter cake when low water loss muds made with My-Lo-Jel can hold down the cost of drilling by eliminating strings of protective casing, preventing delays due to reaming, hole trouble and fishing jobs!

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Complete
DRILLING MUD SERVICE
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WHAT'S DOING IN DRILLING

1000-bbl a Day Well Drilled by Carter

A 1000-bbl a day well has been brought in by Carter Oil Company in Nemaha County, Kansas. The well is the Mamie Strahm No. 2 3½ miles south and 1¾ miles west of Sabetha. Oil was struck in the Viola limestone at a depth of 3572 ft, Carter officials stated. Should further tests indicate deeper oil-bearing strata, a 2000-bbl well is not out of the question. Drilling is continuing after Carter officials ordered a deeper probe to explore the strike possibilities. The No. 1 Strahm is a 25-bbl a day producer, 350 yards southwest of the latest discovery.

Gulf Completes Denton Well

The L. R. Chamberlain No. 1 has been completed by Gulf Oil Corporation as the second Devonian producer in Denton field of central-east Lea County, New Mexico. The well flowed 1092 bbl of 41.6 gravity oil in 24 hr on a ¾-in. choke. Gas-oil ratio was 889-1. Production was from open hole in the Devonian between 11,501 where 7-in. casing is cemented. Total depth is 11,513 ft.

Pure Test Below 13,000 Ft

Pure Oil Company's test well at Badwater, Natrona County, Wyoming is drilling below 13,790 ft after whipstocking by fish. The well was originally drilled to 14,154 ft before a twist-off. It was scheduled to 16,000 ft to Frontier sands productive at West Poison Spider field.

Frederick Pool Well

A flowing producer has been added to the Frederick pool in Tillman County, Oklahoma. It is S. D. Johnson's No. 3 Whitmore. The well flowed 90 bbl of 44.6 gravity oil in 24 hr through a 12/64-in. choke from the upper sand zone. Pipe was set at 2800 ft.

Redwater Offset Drilled

Imperial Oil, Ltd., has spudded the first follow-up to its Simmons No. 1, the well that established a three-and-one-half mile southeastern extension to the Redwater field. Imperial-Simmons No. 2, the new well, is being drilled a mile northwest of the fourth meridian, and is a south offset to the Redwater No. 4-36.

Fowler Field Gets 2nd Well

The second well in the South Matix Unit from the Ellenburger in Fowler field, Lea County, New Mexico is being completed from the Ellenburger, by Stanolind Oil and Gas Company and associates. The well flowed 93 bbl of pipe line oil in three hours on a drill stem test between 10,255-305 ft. An additional 45 bbl of oil were recovered from the drill pipe when the pipe was pulled. Ellenburger was topped at 9942 ft.

Extends Montague Pool

Mid-Continent Petroleum Corporation has completed a one-half-mile extension to an oil pool recently opened in Montague County, Texas. The company's No. 1 Marie Seibert produced 350 bbl a day from the Caddo lime. Total depth is 6575 ft, topping the Caddo lime at 6113 ft, and perforated with 88 holes between 6154-65 ft. On state potential, the well flowed 164 bbl of oil in 10 hours through a 10/64-in. choke.

Well Flows 560 Bbl in 11 Hr

Garvin County, Oklahoma has a new prolific producer drilled by Skelly Oil Company. It is the company's No. 5 Immohotichey, plugged back to 6953 ft. The well flowed 560 bbl of oil in 11 hr through a ¾-in. choke and is continuing to test.

Drills 3rd Tucupido Well

A third oil well has been brought in on the 37,500-acre Tucupido well oil concession in Venezuela by Pancoastal Oil Company. The company stated that the well is producing from the Chaguaramas formation from a depth of 3000 ft. It had an initial flow of 1025 bbl a day through a half-inch opening in the pipe.

Production of the Tucupido area now is about 9200 bbl daily, according to Pancoastal.

Completes Indiana Producer For 100 Bbl a Day

Illinois Mid-Continent Company has completed its Heuring-Woolstan Communitized No. 1 well in Gibson County, Indiana. Drilling was completed at a depth of 2120 ft with 25 ft of pay in the Cypress sand, and is expected to produce a minimum of 100 bbl per day. The well is the first of a series being drilled to extend the Owensville, Indiana field.

Illinois Well Extends Field

A semi-wildcat well, the No. 1 Leighty, has been brought in in Lawrence County, Illinois by the Illinois Mid-Continent Company. The well extends a Lawrence County field developed this year by the Big-Dee-Illinois-Mid-Continent organization. The well made 50 bbl in the first half hour on a drillstem test. Pay was topped at 1821 ft in the McClosky sand.

New Drilling Rig Announced

For drilling to a depth of 5000 ft, a new* rig has been announced. This capacity is a conservative rating based on the use of 4½-in. drill pipe with 450 hp input. The new rig was developed primarily to meet a demand for a "one-package" rig incorporating a "narrow type" chain compound drive group, thus facilitating transportation of the rig intact.

The draw works is separately available for use with equipment of comparable capacity and many of its features can also be applied to existing rigs by field shop conversion. The main drum has six hoisting speeds and the rotary can be driven at three speeds. An outstanding feature is the new air-operated, drum-type constricting clutch used in both the master and high drum drive positions.

*Ideal Type 50-A Consolidated, The National Supply Company.

Rotary rigs operating in oil fields in the United States and Canada.*

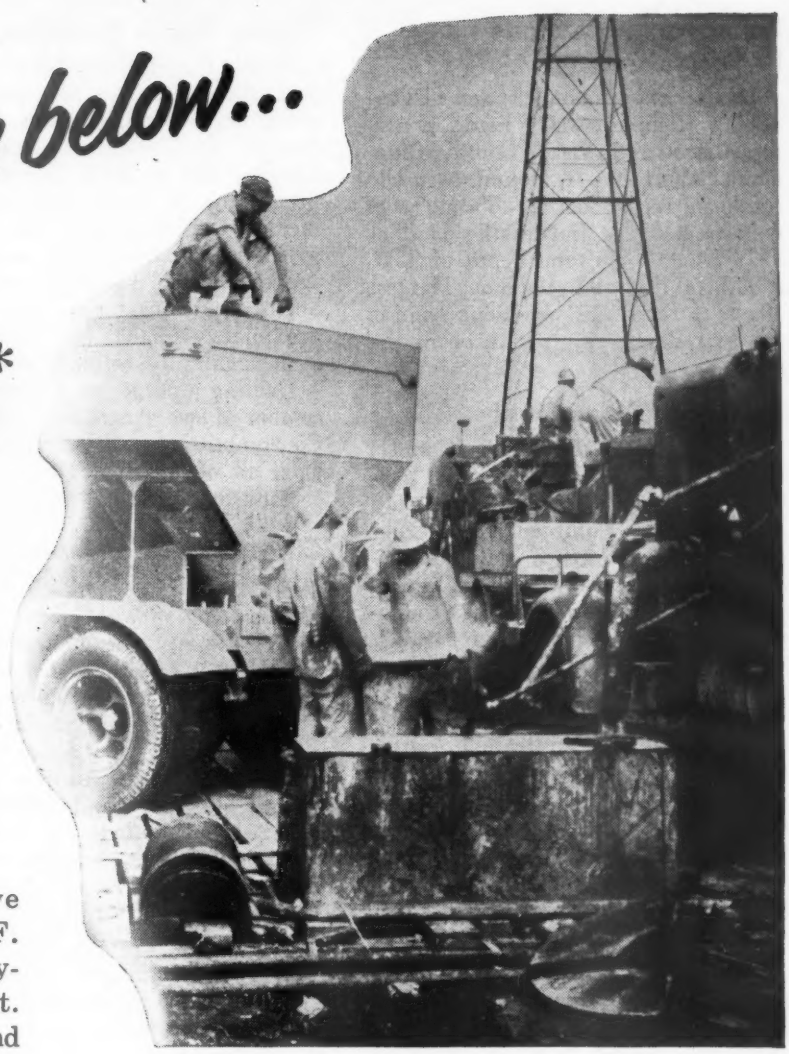
April Weeks	Total	Gulf Coast	Pacific Coast	Oklahoma Kansas	Arkansas, Louisiana, Texas	Illinois	Rocky Mountain, Canada	New Mexico, West Texas
1st	2078	497	135	369	119	94	135	732
2nd	2101	514	128	385	122	94	130	728
3rd	2063	499	131	381	117	91	126	718
4th	2121	501	123	389	136	118	134	720

*Figures released by American Association of Oilwell Drilling Contractors, as reported to them by Hughes Tool Company.

When the pressure's on below...

UNAFLO*

protects your investment 3 ways



When bottom-hole pressures climb above 5000 psi—when temperatures rise over 200°F. and trouble closes in—you can rely on easy-pumping, hard-setting Unaflo Oil-Well Cement. It protects your investment in well, tools and equipment these three ways:

1. Unaflo stays fluid and pumpable under highest bottom-hole pressures and temperatures . . . high *initial* fluidity permits using heavy slurries.

2. Unaflo also has *sustained* fluidity because of its delayed, postponed, retarded set, which allows ample time, even during emergencies, to get cement in place.

3. After retardation, a heavy slurry of Unaflo hardens normally to form a dense, impermeable seal.

To be sure . . . always protect *your* investment with Unaflo!

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Technical information backed up with actual oil-well applications. Easy-to-follow diagrams on various cementing operations. Get your copy of "UNAFLO Oil-Well Cement." Write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

**"UNAFLO" is the registered trade mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company*

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PE-U-115

UNIVERSAL ATLAS CEMENT COMPANY

OIL-FIELD CEMENTS

Unaflo *Retarded* Oil-Well Cement
Resistant to Sulfate Waters
Atlas Portland Cement—Type I
Atlas Portland Cement—Type II
Resistant to Sulfate Waters
Atlas High-Early Cement—Type III

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

Zone Discovery Made In Osage County

Russell Maguire and A. and R. Producing Company have made a new zone discovery in Osage County, Oklahoma. Their No. 1 Hokiahse in the southern sector of the Tidal-Osage field topped the Bartlesville sand at 2279 ft, and at a total depth of 2326 ft had 150 ft of oil in the hole. The test offsets Burgess sand production and is the first Bartlesville producer in the area.

Extends Warren Field

The Warren field of Lea County, New Mexico has been extended one-half mile northwest to McKee sand production by Continental Oil Company. The well rated a daily production of 840 bbl through ¾-in. choke. Gas-oil ratio was 539 to 1. Production was from perforations between 9110-76.

Tests Garvin County Producer

Mid-Continent Petroleum Corporation is testing what apparently will be a good producer in Garvin County, Oklahoma. Its No. 1 Ellithorp Unit flowed an average of 36 bbl of oil an hour for five hours through a 20/64-in. choke, with 603,000 cu ft of gas a day. Plugged back depth is 6967 ft.

LONGER THREAD LIFE WITH Jimmie Gray COMPOUNDS

MONEY BACK GUARANTEE

KANT-GALL TOOL JOINT COMPOUND

EXCLUSIVE 500-TON SPECIAL

LONG-LIFE DRILL COLLAR COMPOUND

Here's real thread protection against galling and washouts! Each one is engineered to do certain jobs best. That's why you can always break the joint when you use Jimmie Gray Compounds!

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Turkey Has 6 Producing Wells

Drilling operations have increased in Turkey in the last few months. Six producing wells have been drilled to date at Ramandag, in southwestern Turkey, and drilling operations are proceeding at three additional wells, including a deep test, well No. 14, which is searching for a second and deeper horizon. Last year saw 91,000 bbl of crude produced, of which approximately 52,000 bbl were refined at the small pilot refinery at Batman.

Drilling operations began in December of last year in the Adana field. Consumption of all petroleum products, all of which are imported, increased markedly in 1949 over 1948.

Cities Service Completes Scurry County Wells

The completion of three wells in Scurry County, Texas was recently reported by Cities Service Oil Company for a per-well initial average of 747 bbl daily. Three producers were completed for a total intial of 3,578 bbl. Completed were Andress No. 3 for a 1144 bbl initial and Austin No. 3 for 1231 bbl, both in the Kelly pool, and Johnson H No. 5 in the Diamond M pool for 1203 bbl.

Hydrofrac Revives Well

Since the development of Hydrofrac, a new chemical process that allegedly makes flowing wells out of failures, many old pools in Oklahoma have been given intensive replay. The new process was tried on R. H. Pierce, Sr., R. H. Pierce, Jr., and A. J. Grasgrin's No. 2 Roy Davidson in Creek County, Oklahoma, resulting in the well's production of 290 bbl net of 40 gravity oil. The gross recovery in 24 hr was 410 bbl. The success of Hydrofrac in the Oiltown East field, oil men predict, will bring about intensive development in the Red Fork of the Pennsylvania.

Japanese Production Up

Modern exploration techniques have resulted in a 33 per cent increase in Japanese crude oil production. G. J. Kaufmann, Standard-Vacuum Oil Company, expressed this belief to the American Association of Petroleum Geologists attending the annual meeting held in Chicago, Illinois recently. Kaufmann stated that production last year averaged slightly more than 4000 bbl a day, compared with 3000 bbl in the preceding year. Although this amount is only a minor fraction of Japan's normal peacetime needs, Kaufmann added that a long standing downward trend in production had been reversed and the outlook for the future is encouraging.

Foresees Expansion of Canada's Oil Program

A $3,000,000 program for development of Canada's oil industry is foreseen by G. L. Stewart, president of Imperial Oil Ltd. Speaking at the company's annual meeting in Sarnia, Stewart stated that 1949 expenditures of the industry for oil finding and attendant developments were $1,000,000, and added that 1950's expenses were expected to be greater.

As of April 15, Imperial had completed 72 development wells in Alberta since the beginning of the year, drilled 8 wildcats, and had four others drilling, Stewart added. "A rough estimate of our company's potential production in Alberta under efficient recovery methods is 60,000 bbl a day at the present time. Our actual production is 26,000 bbl but we expect some increase in this as spring advances, and when the Interprovincial Pipe Line begins to take oil for delivery to Superior that will be a further substantial increase," he stated.

Gas Sector Gets Extension

Stanolind Oil and Gas Company's No. 1 Slater has been completed on a mile south extension to the Woodlawn wet gas field in Harrison County, Texas. Through 18/64-in. choke, the well gaged 4,390,000 ft of gas daily along with 192 bbl of 62.9 gravity distillate. Flowing tubing pressure was 2290 lb. Production is from the Pettit at 6487-97 and 6502-08 ft.

Gulf Well Flows 1252 Bbl in 24 Hr

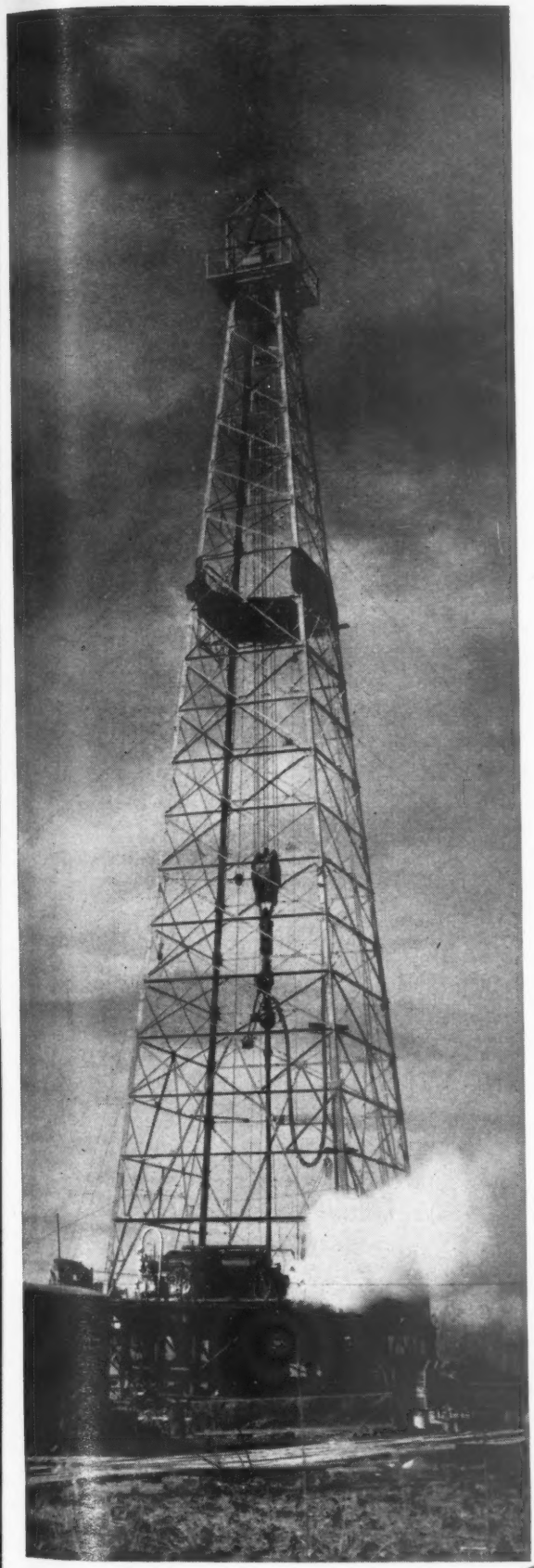
Gulf Oil Corporation has completed its No. 4 Foster in Okfuskee County, Oklahoma as a large producer. The well which was drilled to a total depth of 3484 ft, completed for an initial production of 1252 bbl of oil, without any water, in 24 hr. It was flowing through tubing.

API Publishes Drilling Issue

The 1948 issue of "Drilling and Production Practice," published by the American Petroleum Institute, is off the press.

The book contains papers on drilling and production practice selected by the publications committee of the API's central committee on drilling and production practice from papers presented at national and district meetings of the division of production in 1948.

It will be sent automatically to advance subscribers. Otherwise, copies may be obtained through the office of The Secretary, American Petroleum Institute, 50 West 50th Street, New York 20, New York. Single copies are priced at $5.



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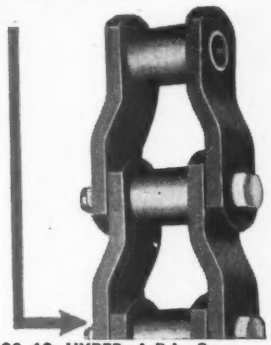
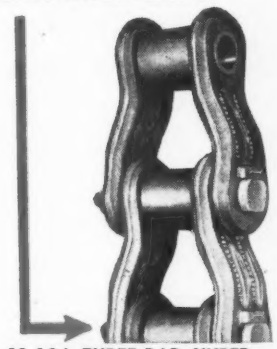
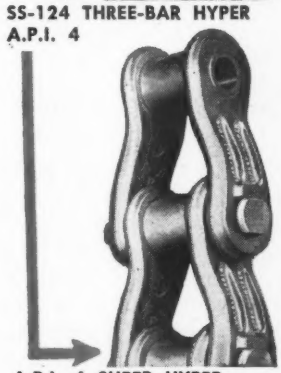
Shallow or Deep . . . Easy or tough



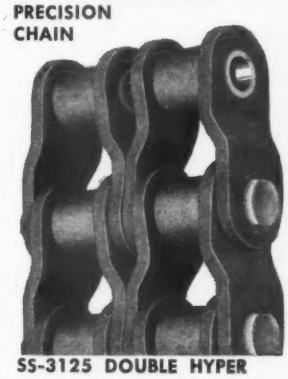
SS-40 HYPER A.P.I. 3



SS-124 THREE-BAR HYPER A.P.I. 4



A.P.I. 4 SUPER HYPER PRECISION CHAIN



SS-3125 DOUBLE HYPER

These Link-Belt oil drilling chains have been engineered and precision-built to "take it", and keep going. From the SS-40 Hyper for your rotary table to SS-3125 Hyper Triple for your hoists and engine drives, you'll find L-B Chain for your requirements.

Well balanced design, proper selection of materials and accuracy in manufacture make these chains the strongest, most dependable for the severe service encountered in oil well drilling.

Link-Belt Chains are carried in stock by your local supply store.

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CHAINS AND SPROCKETS

A Type for Every OIL INDUSTRY SERVICE

EXPLORATION ACTIVITIES

New Sand Opened In Mississippi

Humble Oil and Refining Company has opened a deep production zone in the Wilcox sand section at the company's No. 1 Lucy Barksdale, in southern Adams County, Mississippi. Casing was perforated at 6571-73 ft, and the well flowed at the rate of 198.64 bbl of 41.8-deg gravity oil a day with gas-oil ratio of 206-to-1, through ¼-in. choke. Baker sand was found at 6470 ft, but no name has been given the new deeper sand.

Second Test Drilled in Kuwait

American Independent Oil Company and Pacific Western Oil Corporation are drilling the second test in the Kuwait-Saudi Arabia Neutral zone. At the last report, the well was down to 3500 ft. This second one is west of the first Neutral Zone test, which was abandoned at about 5020 ft in February.

The well is being drilled by Kerr-McGee Oil Industries, Inc. and Brown Drilling Company.

Shell Makes Kansas Strike

Shell Oil Company's wildcat in Hodgeman County, Kansas has indications of a new strike for that state. The No. 1 Springer is two miles north of Jetmore and 20 miles south of production in adjoining Ness County. The well went to 2250 ft of oil from Sooy (basal Pennsylvania) rocks from 4559-84 ft. An additional 1100 ft of gas and 30 ft of oil cut mud accompanied the 45-min test.

Drilling deeper into Mississippian, cut at 4594, a drill stem test was taken from 4599 to 4649 ft that recovered 60 ft of oil and 160 ft of very heavily oil cut mud in one-half hour, the oil measuring 38.8 gravity. Operators plan to drill farther, testing deeper formations.

Geophysical Plans Made For Testing in Ethiopia

Testing has been abandoned at the No. 1 Gumburo well in the Ogaden area of Ethiopia by Sinclair Petroleum Company. A depth of more than 10,000 ft has been reached. Company officials stated that geological data obtained has caused them to proceed with an extensive geophysical program and that geophysical operations will be augmented by surface geological studies and magetometer survey.

Two Major Strikes in Kansas

One of Kansas' major strikes this year has been made at Winkler-Koch and Stanolind Oil and Gas Company's No. 1 Cornwell near the southern edge of the Forest City basin in northern Lyon County. The well swabbed 20 bbl of oil hourly from the Hunton line, topped at 2951 ft.

At the same time almost 12 miles south of the No. 1 Cornwell, another strike was made northwest of Emporia, Kansas, on the southeast edge of the Forest City Basin, major geological province that extends north into Nebraska, Iowa, and Missouri. Ray Anderson and his associate's No. 1 W. T. Ball is going on pump after filling with 10 ft of water and 80 ft of 35 gravity oil in one hour. It tapped Kansas City rocks drilled to 1612 ft, total depth.

New Zealand Gets First Commercial Oil Production

The first oil in commercial quantities has been found in New Zealand by the New Zealand Oil Refinery, Ltd., the Mining Journal of London reports. The well, the No. 1 Dobson, is situated in the Taranaki field in the North Island. It was drilled to 2226 ft, and flowing at a rate of 25 bbl a day under natural pressure. It will be further explored and developed by its owners, who also propose to set up a cracking plant.

Make Oil Find in Pecos

Oil production has been opened in the Abell Silurian-Montoya pool of Northern Pecos County, Texas, with completion of George T. Abell's No. 1 L. G. Byerly. The well flowed 120 bbl of oil daily after acidizing the lime pay from 4915 to 4940 ft with 1000 gal.

Gaines County Has Deep Field

A new deep oil field has been completed in Gaines County, Texas by Forest Oil Corporation and Anderson-Prichard Oil Company. After testing dry in the Ellenburger at 14,085-150 ft, the well was plugged back to 13,454 ft. Casing was perforated opposite the Mississippi lime at 12,100-235 ft. On state potential test the well flowed 203 bbl of oil a day through a ½-in. choke, with gas-oil ratio of 1025-to-1. On first 24-hr test the well flowed 335.78 bbl of oil through a ⅜-in. choke.

New Well Drilled In Gulf of Mexico

Discovery of what is said to be the best well to date in the Gulf of Mexico has been made by Magnolia Petroleum Company and the Continental-Newmont Oil Companies, joint developers of the well. With an initial potential of more than 700 bbl per day of 33-gravity crude, the well is 25 miles off the coast of St. Marys Parish, Louisiana and 65 miles south of Morgan City. It is believed to be farther offshore into tidal water than any other well in the world, and is situated in Magnolia's Eugene Island Block No. 125.

Drilling of the well began last November. Oil was found in Miocene sand at a depth of about 11,650 ft. The well flowed at a rate of 789 bbl per day when tested for two hours on a 14/64-in. choke. The porosity of the producing sands varies up to 26 per cent.

Begin Oil Research in Italy

Western Geophysical Corporation of California has begun oil research around Modena, Italy south of the Po River. Research is sponsored by the Italian state-controlled oil company, AGIP. Work has begun near the towns of Campo Galliano, Soliera, Limidi, and Novi di Modena. AGIP made some drillings in the area in 1927-28, discovering and developing a methane gas well that eventually dried up.

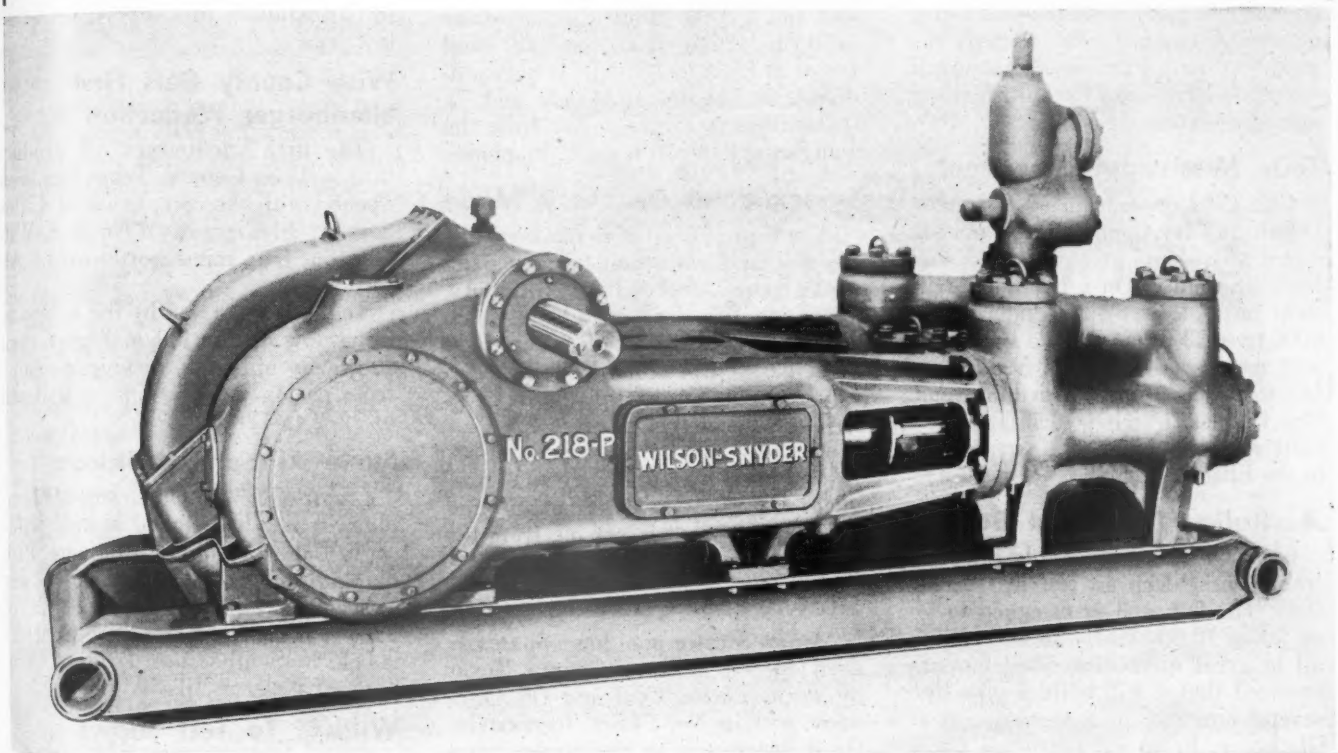
Lime Pool Opened in Texas

A new Glorietta lime oil pool has been opened in Yoakum County, Texas by Honolulu Oil Corporation, with completion of its No. 1 Paul Cobb in the northeastern part of the county. The well was completed to pump 189 bbl of 23 gravity oil in 24 hr through casing perforations from 6035 to 6200 ft, after 5000 gal of acid.

Strawn Oil Pool Opened

Texas Pacific Coal and Oil Company has opened a new Strawn sand oil pool in Haskell County, Texas six miles northwest of Rochester with completion of its No. 1 McGregor, to flow 211 bbl of 41 gravity oil daily. Production is through casing perforations from 4969 to 4973 ft. The new strike is three miles northwest of the Jud pool.

"Light Heavyweight" Champ



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SIZE (Bore and Stroke)	inches	7¼ x 18
LINER SIZES (DI-HARD)	inches	5, 6, 6½, 6¾, 7, 7¼
HYDROSTATIC TEST PRESSURE:		
Discharge	p.s.i.	6,000
Suction	p.s.i.	3,000
RATED WORKING PRESSURE:		
Discharge	p.s.i.	3,000
Suction	p.s.i.	2,000
RATED B.H.P. AT 60 R.P.M.		450
MAXIMUM WORKING PRESSURE WITH FULL SIZE LINERS	p.s.i.	890
GEAR RATIO		4.95:1
PINION SHAFT EXTENSION:		
Diameter by Length	inches	5.995 x 17
Keyway Width and Depth	inches	1½ x ½
FLUID SUCTION CONNECTION (10" x 17½" Ser. 300 Companion Flange) PIPE SIZE		10"
FLUID DISCHARGE CONNECTION: Air Chamber (4" x 10¾" Series 600 Companion Flange) PIPE SIZE		4"

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Wagoner Named President

George E. Wagoner of Carter Oil Company was elected president of the Society of Exploration Geophysicists at the group's annual meeting in Chicago, Illinois. Manager of exploration in Carter's southern division, Wagoner is the former vice president of Exploration Geophysicists. Sigmund Hammer of Gulf Research and Development Company was elected vice president and Francis F. Campbell, Amerada Petroleum Corporation, was named secretary-treasurer.

Tests Mississippi Lime Pool

Gulf Oil Corporation's No. 1 A. R. Dillard in Clay County, Texas may be a new Mississippi lime oil pool opener for that county. On a two-hour drillstem test, of the Mississippian from 6000 to 6023 ft gas showed in 25 min, with recovery of 133 ft of free oil and 145 ft of heavily oil-cut drilling mud. The wildcat, which is drilling below 6101 ft in the Simpson, is contracted to the Ellenburger.

Australian Deep Test Begun

Shell Oil Company has begun Australia's first deep oil test in Queensland. The test well is designed to go as far as 10,000 ft. If the well strikes oil in great quantities, Shell has announced that it will build a pipe line several hundred miles to the coast at Gladstone. From Gladstone oil could be shipped to Sydney or Indonesia for refining, Shell's Australian general manager, E. N. Avery, announced. He added that if the Sydney refinery proved inadequate, the company would build another large refinery.

Producing Area Opened In Lincoln Parish

A new gas-condensate producing area has been opened in Lincoln Parish, Louisiana by Southwest Natural Production Company. The well, No. 1 Colvin, was completed as a dual producer. By company gage the well flowed at the rate of 75 bbl of condensate and 1,000,000 cu ft of gas daily on ¼-in. choke from the "D" sand found at 8556 to 8572 ft. It also produced 50 bbl of condensate and 7,000,000 cu ft of gas a day from the Vaughn at 8738-56 ft on ⅜-in. choke.

Sussex Sand Discovery Made

A new producing zone has been discovered by Continental Oil Company in the Sussex sand of Johnson County, Wyoming. It is the No. 15 Unit, which recovered 600 ft of clean oil and 150 ft of gassy oil-cut mud on drillstem test of a new Sussex sand at 4123-58 ft. The wildcat is producing from the Wall Creek and Lakota sands. Sussex field, 2 miles west of No. 15 well, produces from the Sussex, Shannon, and Lakota zones, but is cut off from the new area by a dry hole.

Strawn Pool Opened

A new Strawn pool has apparently been opened in Knox County, Texas by Texas Pacific Coal and Oil Company, with its No. 1 Louis Cartwright. On drillstem test to the Strawn sand from 4530 to 4535 ft, open 90 min, gas showed to the surface in 8 min with recovery of 3870 ft of free oil and 30 ft of oil-cut mud. Drilling is contracted to the Ellenburger and continued below 4556 ft.

Texas Wildcats Up In 1950

The Texas Railroad Commission reports that exploring for oil in Texas is more successful this year than last. Discoveries so far this year total 171, up 23 from a like period of last year. Gas discoveries are down, with 19 new fields compared with 35 over the same period of time last year. Drillers failed in 678 wildcats this year against 640 last year.

Wise County Gets First Ellenburger Production

The first Ellenburger oil production in Wise County, Texas has been opened with the completion of Cities Service Oil Company's No. 1 S. Williamson, four miles northwest of Alford.

The well was rated by the company for a flow of 265 bbl of higher than 40 gravity oil a day. Production came from casing perforations at a depth of 7272 to 7288 ft.

Stake Alabama Wildcats

Lazarov-Robilio Oil Group of Memphis, Tenn., has staked a new wildcat in Baldwin County, Alabama. Production will be sought in the Lower Tuscaloosa to a projected depth of 7200 ft at the No. 1 Ben May. Contract is held by Southeastern Drilling Company of Jackson, Mississippi.

Wildcat To Test Shows

Wilcox Oil and Empire Oil of Texas' No. 1 Ross Dugger is running casing after logging good shows in the Hoxbar conglomerate, with another outpost staked 3½ miles south of the promising wildcat in Beckham County, Oklahoma. The new wildcat was drilling with Wilcox tools to a total depth of 10,645 ft. Only drillstem test reported was made at 10,156 ft to 10,249 ft, with the one-hour opening recovering 200 ft of oily mud and 250 ft of water.

Make Jack County Discovery

Brown Drilling Company of Long Beach, California and partners have a new discovery in Jack County, Texas. This well penetrated the Strawn series and picked up 13 ft of well saturated oil sand. A test of the interval produced a substantial rise of clean oil. Seven-inch casing was cemented at 3563 ft.

Tests Elk City Well

Shell Oil Company and Continental Oil Company's No. 1 Reynolds in the Beckham County, Oklahoma sector of the Elk City field is flowing on test. Plugged back depth is 9902 ft. The well flowed 316 bbl of oil, 66 bbl of mud, 164 bbl of salty water, and 2,062,000 cu ft of gas in 17 hours through a 24/64-in. choke.

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Continental Test Opens New Pool for Wyoming

Continental Oil Company has discovered a new pool in Johnson County, Wyoming, with the completion of its Meadow Creek Unit well No. 1, an exploratory test 15 miles north of Midwest. The well flowed 39 gravity oil at a daily rate of 192 bbl through 15/64-in. choke.

The well is producing from the Lakota sand, and is three and one-half miles south of the nearest other Lakota production in the Sussex pool. Total depth is 7555 ft. Casing is set at 7554 ft, and perforated from 7504 to 7530 ft, and from 7475 to 7490 ft.

Kentucky Oil Area Indicated

Indications of a new Kentucky oil-producing area two miles south of the town of Smith Mills are prevalent at the test well, No. 1 Charles Trigg. The well, owned by J. Reznik and C. P. Chandler, found production three miles from other oil wells. Production is from the McClosky limestone at 2586 to 2590 ft, and the total depth is 2591 ft.

On a one-hour drillstem test from the McClosky limestone, gas was recovered in 11 min, and 810 ft of clean oil was found, with no mud and no water. Pipe has been set and preparations are being made to begin cleaning out and testing the well.

Opens Mississippi Oil Field

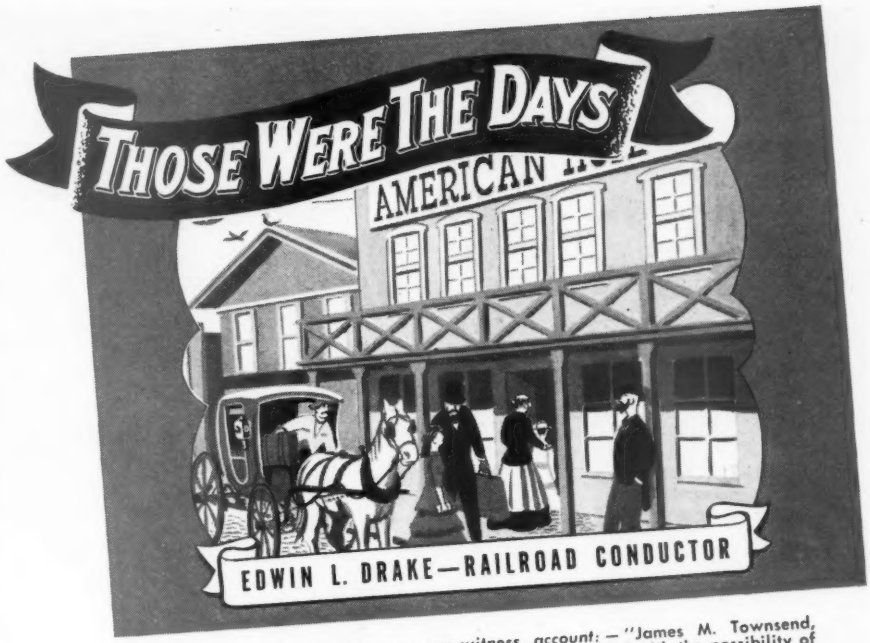
Pan American Production Company of Houston, and Roeser and Pendleton, Inc., Fort Worth, Texas, have opened a deep oil field in the western area of Lincoln County, Mississippi. The No. 1 S. H. Holloway, flowed 158 bbl of 42 gravity oil daily through a 10/64-in. choke from 10,650 to 10,680 ft in the Tuscaloosa sand. Tubing pressure was 740 lb and gas-oil ratio was 1200 to 1.

Payne County Pool Opener

Payne County, Oklahoma may have a new pool opener at the Kingwood Oil Company's No. 1 Murphy. A one-hour drillstem test was run at the wildcat, situated west of the North Coyle pool, opposite the Bartlesville sand between 4782 and 4806 ft, with recovery netting 90 ft of oil and 130 ft of heavily oil-cut mud. Casing was landed at 4776 ft.

New Illinois Area Opened

A new area has been opened in Clay County, Illinois by the Texas Company. The No. 1 R. L. Harrell has been completed for 258 bbl of oil a day from the Benoist sand at 2581 to 2604 ft. Total depth is 2604 ft and well was stopped in saturated sand. It is ¾-mile from other oil wells.



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running tour with men in the industry

▸ **Glenn M. Stearns,** engineer for British American Oil Producing Company, in Tulsa, Oklahoma, has been elected chairman of the Mid-Continent district, division of production, American Petroleum Institute. He succeeds **J. H. Field,** Sohio Petroleum Company, Oklahoma City.

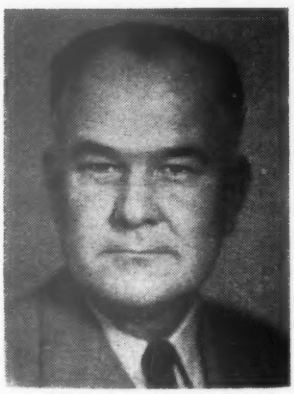
Other officers elected are **Harold E. Berg,** Tide Water Associated Oil Company, Tulsa, vice chairman for northeastern Oklahoma; **Harold Spillers,** Carter Oil Company, Seminole, vice chairman for southwestern Oklahoma; **W. D. Maxwell,** Carter Oil, vice chairman for Kansas; **Ralph O'Neill,** Phillips Petroleum, Borger, Texas, vice chairman for the Texas Panhandle; **Fred Neslage,** Pampa, Texas, secretary-treasurer and **Field,** chairman of the committee.

▸ **Donald M. Murphree,** British-American Oil Producing Company, is now in Houston, Texas, where he was transferred from Casper, Wyoming. **J. E. Matter** has been transferred from the Western division to become area exploration manager of the Fort Worth and West Texas area.

G. M. Piggott has been promoted from district geologist to area exploration manager of the Louisiana, Arkansas and East Texas area. His office will remain in Shreveport. **C. Harrison Cooper,** British-American geologist, has been assigned to the West and North Texas and Southeast New Mexico area. He was formerly in Oklahoma City. **E. L. Earl** was recently named area exploration manager in charge of the Gulf Coast area. His headquarters will remain in Houston, Texas.

▸ **F. D. Leigh,** mechanical engineer, East Texas division, has been transferred to the Midland area, production department; **W. A. Fletcher,** construction and maintenance foreman, East Texas division, has been named production foreman; **O. J. Shirley,** junior exploitation engineer, Houston area, has been transferred to Corpus Christi and promoted to exploitation engineer.

▸ **Cloyd R. Wallace,** The Texas Company, has been promoted to assistant division manager of the geophysical division, producing headquarters at Houston, Texas. Wallace was an instructor in geology at Texas A&M prior to joining The Texas Company as an assistant computer in the geophysical division in 1934.



Fred C. Ripley

Lee J. Laird

▸ **Fred C. Ripley, Jr.,** International Derrick and Equipment Company, Torrance, California, and **Lee J. Laird,** Gil-Liar Products, Inc., Pasadena, California, have been appointed chairman and secretary-treasurer, respectively, of the board of regents of the five chapters of Nomads.

Ripley is one of the founders of the society, being a charter member of the Los Angeles group, which began as a purely local organization in 1938. He has been continuously active in Nomad affairs since then. Laird has been a member since 1944, and served as president of the Los Angeles Chapter last year.

The five chapters are in Dallas-Fort Worth, Houston, Texas, Los Angeles, California, New York, and Tulsa.

▸ **Wayne H. Denning,** United Geophysical Company, Inc., has been appointed area supervisor in the Mid-Continent area, with headquarters in Tulsa, Oklahoma.

A graduate of the Colorado School of Mines, Golden, Colorado, Denning joined United in 1938 after 12 years as geologist and geophysicist for Stanolind. He spent six years as United's supervisor of Brazilian operations, with headquarters in Rio de Janeiro. Since that time he has supervised United's operations in Puerto Rico and has just recently been area supervisor for California, Wyoming, and West Texas, with headquarters in Pasadena.

N. J. Christie, former area supervisor in Tulsa, Oklahoma, has resigned his position with United to join a new firm with headquarters in Canada.

▸ **L. D. Hillyer,** exploitation engineer, Shell Oil Company, has been appointed production geologist, and transferred to the company's Houston area production department.

▸ **Frank Reedy, Jr.,** has been designated winner of the 1950 president's award of the American Association of Petroleum Geologists. The award is made annually to the author, under 35 years of age, of the most significant original contribution to petroleum geology during the preceding year. The award, which was presented at the association's annual convention in Chicago, Illinois, last month, was given Reedy for his paper, entitled: *Stratigraphy of Frio Formation, Orange and Jefferson Counties, Texas.*

Reedy is employed by the Crown-Central Petroleum Corporation in Houston, Texas. He is a graduate of Southern Methodist University, and holds an MA degree from the University of Texas.

▸ All officers and directors of the San Joaquin Valley Oil Producers Association were re-elected for another year. They are **E. E. Pyles,** president; **H. F. Owen,** vice president; **L. W. Saunders,** vice president; and **C. O. Premo,** secretary. The board of directors consists of **L. L. Aubert, L. A. Cranson, J. M. Feldman, Richard Fenton, R. E. Gignoux, W. M. Keck, Jr., R. E. McCarthy, Ross McCollum, Harold R. Pauley, E. C. Reid, J. B. Spellacy,** and **W. C. Whaley.**

▸ **Irving M. Griffin, Jr.,** has opened consulting offices in Houston, Texas. He was formerly with General Geophysical Company as seismic supervisor of the Pacific Coast and Rocky Mountain divisions.

▸ **William E. Colson,** geologist, formerly with Barnsdall Oil Company, has joined Horsting Oil Company. He will work out of Horsting's headquarters at Driscoll, Texas.

▸ **Walter B. Pyron,** vice president of Gulf Oil Corporation for foreign production, was recently decorated by the Mexican Government. He was awarded the Military Merit Medal of the First Class in recognition of his work during World War II in strengthening friendship and understanding between the United States and Mexico. Pyron has been a representative in London for Gulf for several years.

▸ **John A. Brineman,** geologist for Socony-Vacuum Oil Company, Inc., has been transferred from Colombia to the Magnolia Petroleum Company in Dallas, Texas.

▸ **Robert G. Mills,** former party chief for United Geophysical Company, Inc., in Canada, has accepted a position as seismologist with British-American Oil Company in Canada. **C. C. Lister,** has recently returned from an extended trip to the Middle East, inspecting United's operations in that area.

▸ **Jess O. O'Neal,** has been promoted to division superintendent of Continental Oil Company's Montana-Wyoming division. He succeeds **Ira D. Pierson,** who recently retired. O'Neal was formerly district superintendent at Griffin, Illinois.

▸ **J. L. Jodry** was recently named chief geologist for Rex Oil and Gas Company, Muskegon, Michigan. He was formerly employed by Ohio Oil Company at Grand Rapids, Michigan, and prior to that was with Magnolia Petroleum in Louisiana and Texas.

▸ **J. K. Somerville,** junior geologist, Shell Oil Company, Houston, Texas, has been named subsurface geologist at Lake Charles, Louisiana. **A. R. Newman,** exploitation engineer, has been transferred to New Orleans, Louisiana, from Donaldsville, Texas, in the same capacity.

▸ **Anthony E. L. Morris** has been appointed West Coast division geologist for D. D. Feldman Oil and Gas Company, with offices in the Holmby Building, 921 Westwood Boulevard, Los Angeles, California. Morris was formerly a geologist with the General Petroleum Corporation in Bakersfield.

D. D. Feldman is a comparative newcomer on the Pacific Coast with crude and gas production in South Mountain, Santa Paula, Signal Hill, and Rio Vista. The D. D. Feldman organization was directly responsible for the discovery of the eastward extensions of the Rio Vista gas field. Executive offices are in Dallas, Texas.

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▸ **Howard M. Walker** has been promoted to assistant division superintendent of Magnolia Petroleum Company's Gulf Coast producing division with offices in Houston, Texas. He is being replaced as assistant district superintendent of the Lake Charles, Louisiana, district by **C. B. Swain.**

Kenneth L. Nelson, assistant foreman in the Kermit, Texas producing district, has been promoted to production foreman in that district. **Wade L. Strange,** assistant foreman, has been transferred from the Brownfield, Texas producing district to the Lake Charles district.

Thomas E. Wright has been promoted to assistant foreman in Magnolia's Brownfield producing district. **Clarence E. Rabb,** petroleum engineer in the Lake Charles producing district, has been transferred to assistant production foreman in the Shreveport district. **William C. Dougherty** has been transferred from the petroleum engineering department to assistant production foreman in the Kermit producing district.

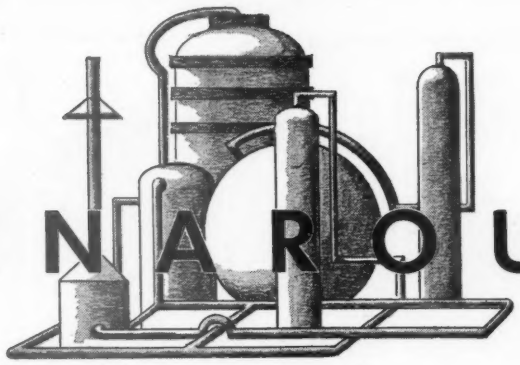
James R. Puckett, district petroleum engineer in the Duncan, Oklahoma district, has been transferred to the Kermit producing district, where he will become district petroleum engineer. **V. M. Leonard,** petroleum engineer in the Electra, Texas district, has been promoted to district petroleum engineer in the Duncan, Oklahoma producing district.

D. F. Pendley, Jr., petroleum engineer at Duncan, has been transferred to the Electra district as petroleum engineer. **J. Patrick Keating,** petroleum engineer at Dallas, has been moved to the Electra producing district as petroleum engineer.

Joseph Neely, who has been district geologist of the Illinois district for Magnolia Petroleum Company, at Mount Vernon, Illinois, has been transferred to Dallas, Texas as regional geologist. **H. A. Sellin** has been promoted to district geologist in charge of the Illinois district. Mr. Sellin was formerly a resident geologist at Tallahassee, Florida.

▸ **David W. Sellery,** Casper division land man of The Ohio Oil Company, died recently at Casper, Wyoming. Sellery joined Ohio Oil in 1925 as a scout in New Mexico, after several years as a leaser in New Mexico and California, he was appointed Los Angeles division land man in 1941. He was transferred to Casper last year.

▸ **Robert R. Shaffer,** Stanolind Oil and Gas Company, has been transferred from Levelland, where he was a roustabout engineer, to Odessa, Texas as a roughneck. He will make his home in Odessa.



THE TURNAROUND

Processes, Ancient and Modern

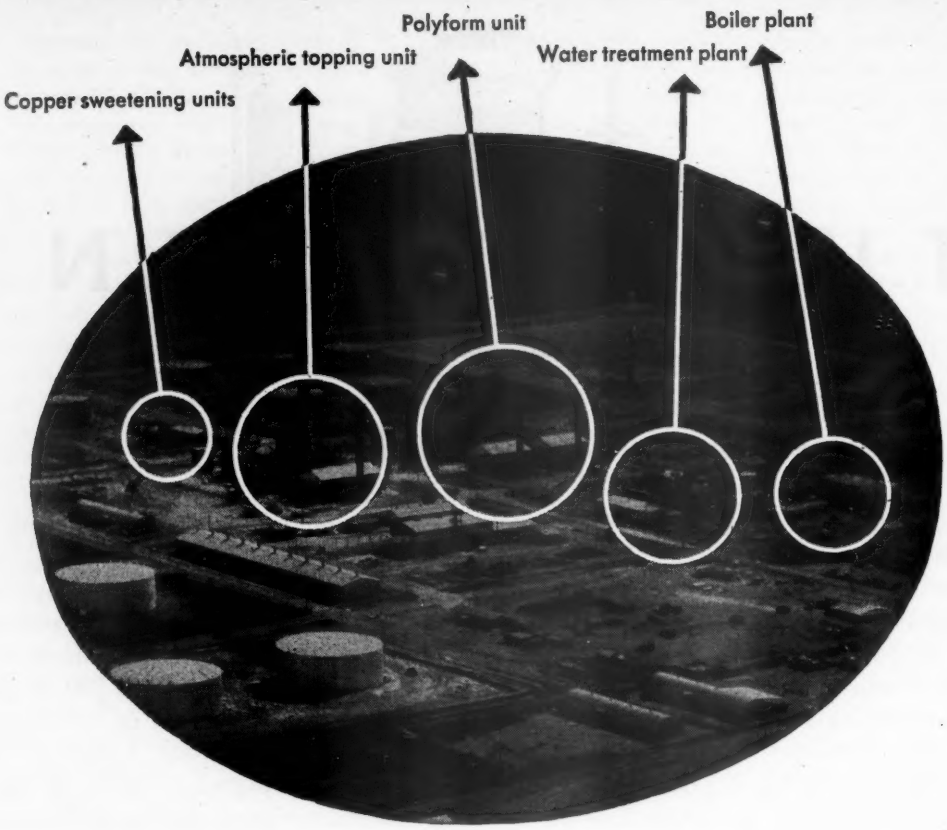
STRONG statements have been read into the Congressional Record in the effort to show that the so-called Karrick low temperature carbonization method for treating coal is the answer to the problem of recovering large quantities of "oil" to relieve the alleged shortage of petroleum in the U. S. A. These statements assert that this "process uses low pressure steam to distill ordinary soft coal." From this system a smokeless solid fuel is made, amounting to 75 per cent of the original charge or 1500 lb per ton of raw coal. Also 3500 cu ft of fuel gas, 10 gal of 'cresols', 26 gal of 'crude oil' and 100 kw of electrical energy are produced from this ton of coal. Costs of raw material and processing is given at $10.80 per ton, leaving a potential profit of more than $5 per ton for the operators. It is asserted that the oil products can be given away and still leave a 10 per cent profit!

These claims for this process are refuted by none other than Dr. James Boyd, experienced and practical head of the Bureau of Mines, who points out that the Karrick process "is merely one of the least efficient and most obsolete of the many variations of low temperature carbonization, a coal-processing method which has been well known for several decades." Referring to the high yield of solid fuel, Boyd says "to produce any significant quantity of liquid fuels by coal carbonization would glut an already saturated solid-fuels market with fantastic quantities of unsalable coke or char." Coal carbonization was eliminated long since by the Bureau as a source of liquid fuels because of a multiplicity of disadvantages, which drawbacks Boyd enumerates. The liquid from the process is tar, not petroleum, he states.

On the face of it, the weight of evidence appears to be overwhelmingly against the practicability, at present, of the Karrick method. Nor does the accusation that so-called German processes are being exploited by Federal agencies for the advantage of a few major oil companies, appear to have a shred of truth to support it. The effort in this case is directed obviously against Federal publicity agencies, which themselves have worked hard to sell synthetic fuel programs to the public, frequently failing to tell the whole story of these methods. Members of Congress are being approached by proponents of the Karrick scheme with charges against the good faith of Federal technical agencies, so far without discernible result.

Sharp differentiation must be made between the publicity efforts of probably overly enthusiastic Federal agencies such as the synthetic fuels program and the well established practical work of technical groups such as the U. S. Bureau of Mines Petroleum and Natural Gas Division, and others. These groups long ago developed needed and practical functions, which have accomplished an outstanding job of aiding both these two industries and the Federal government and consequently, the whole American people. Within the organic purpose of these groups a great deal of very important work has been and is being carried out; much data on many important subjects so obtained are in wide use by the industry. No extraneous developments should cause us to confuse the value and usefulness of the work of these well integrated groups or the bona fide character of their efforts, with any overly enthusiastic or misguided activities of more recent units such as synthetic fuels.

Arch L. Foster



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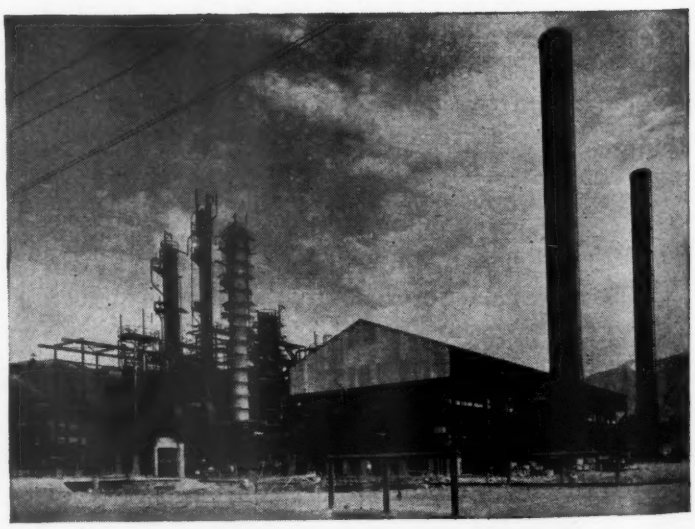
Currently going "on stream" is this completed and fully integrated 40,000 B/D Refinery. Clearing and grading at plant site was begun in February 1949. Once under way, the commitments of the planned work schedule were fulfilled before due date, with a significant time saving on the completed job.

The refinery is to produce motor fuel, diesel fuel, bunker C oil and liquid propane from E. Venezuela crude. Major units in the project, as shown on this page, include: (1) atmospheric topping unit and desalting unit, (2) naphtha-gas oil polyform unit of 32,000 B/D capacity, (3) two 10,000 B/D copper sweetening units, and complete water treatment and power supply facilities.

Completion of plants well in advance of schedule, reflects the thorough planning and sound construction experience which Lummus will bring to your next project —wherever it may be.



Naphtha-gas oil polyform unit. The gas oil is cracked once-through in the presence of propanes and butanes in a Lummus heater. Naphtha with propanes—butanes is cracked in the same furnace.

Choice of Grease Making Equipment

Summary of the best practices and most efficient equipment developed for lubricating grease manufacturing industry.

C. J. BONER*

IMPROVEMENT in equipment employed for the manufacture of lubricating greases has kept pace with that of the machinery on which the lubricant is used. The greatest advance in lubricating grease making equipment has occurred in the last 10 or 15 years; however, the lubricant requirements of World War II were responsible for some of this development.

Klemgard[1] in 1937 made the following statement: "It is estimated that within the United States the total capital investment in lubricating grease manufacturing plants is roughly $5,000,000." Contrast this with a modern lubricating grease manufacturing and oil packaging plant completed late in 1948, at a cost of approximately $7,000,000. This plant can produce more than 38,000,000 lb of lubricating grease per year and the total production of lubricating grease in the United States will probably exceed one and a quarter billion pounds in 1950. This latter figure indicates why the choice of equipment for such operations is worthy of consideration.

Twenty years ago such equipment was largely custom built and design of the same was based entirely on empirical factors. Through a gradual evolution the lubricating grease manufacturer is now offered standard equipment that is well "engineered". In many cases the equipment is offered as a package unit that will perform more than one function (Fig. 1). In a few instances equipment designed for other industries, such as the Votator (Fig. 2), has found application in lubricant processing.

The employment of improved equipment has been justified because of increase in cost of both raw materials and labor as well as because of the necessity of improved control so that products controlled closely by specifications can be manufactured. Also certain types of lubricating greases now produced could not have been manufactured without such improved equipment.

*Battenfeld Grease and Oil Corporation.

Function of Lubricating Grease Manufacturing Equipment

The equipment required for the manufacture of lubricating greases must function for one or more of the following purposes: 1. *Movement of fluids*—the product handled may be either liquid or plastic so normal calculations for the flow of liquids will not always hold; 2. *Heat transfer*—this is required first, to raise the temperature of the ingredients and second, to promote solution or reaction. Although some of the reactions are exothermic, heat is always necessary to initiate the reaction. In some cases cooling is required; 3. *Mixing*—first, to effect most intimate contact of reacting ingredients and second, to incorporate oil and other components into the soap matrix; 4. *Partial or complete dehydration*—to effect removal of either the water employed as a solvent for the alkali or that formed through reaction of alkali and fatty acids; 5. *Milling*—for the purpose of making the product smoother or in order to incorporate solids into the mixture; 6. *Vacuum treatment*—to remove entrained air.

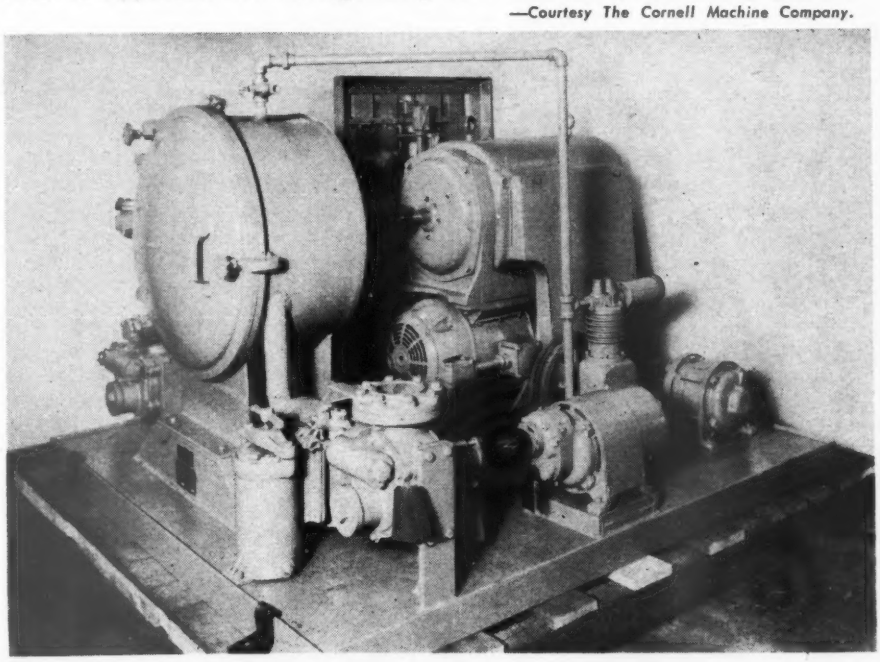
Types of Processing

Any of the above processes may be carried out by batch or continuous cycle. As the former procedure permits of the greatest versatility, it is used largely. The present continuous or semi-continuous processing equipment now available will not handle all types of greases. Although we do not have a comparison of the relative investment or operating costs of the two types of equipment for a stated production, it seems logical that, with further improvements a semi-continuous or continuous process for the manufacture of lubricating grease should have advantages over batch processes for many lubricants.

Equipment for Fluid Handling

The bulk of the raw materials required for the manufacture of lubricating greases consists of mineral oils and fats or fatty acids that are received in tank cars or barges. Storage and connecting pipe lines for such oils and fats are similar to those required for any establishment handling lubricating oils. Either two or three-inch welded lines will supply the volume

FIG. 1. Apparatus for homogenizing and deaerating lubricating grease. —Courtesy The Cornell Machine Company.



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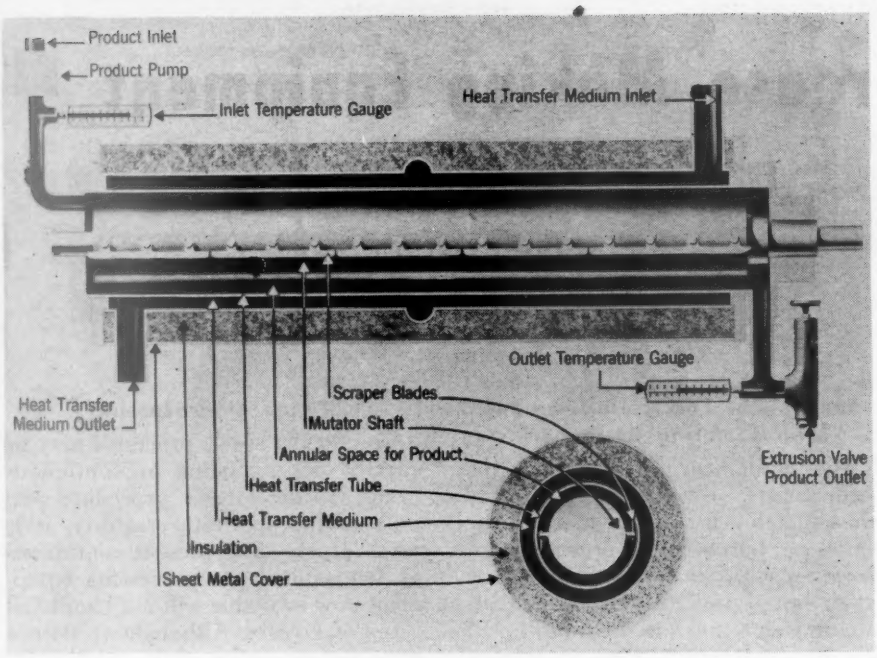


FIG. 2. Cross-section of Votator for heating and cooling lubricating grease. —*Courtesy The Girdler Corporation.*

normally required for grease manufacture. Such oils can be handled by electrically driven centrifugal or rotary gear pumps situated at each storage tank, with controls for the same on the operating platform so that the oil will be delivered directly to the compounding system. Almost all of the oils used in grease manufacture can be pumped at pressures of 50 psig, provided the oils have been warmed and the pipe lines are of adequate size. When positive delivery pumps, such as rotary pumps are used, they should be equipped with protective devices such as pressure relief valves, excess pressure governors or pressure switches. This will permit a valve to be shut against operating pumps without damage or, in some cases constant pressure can be maintained on a line. If a constant oil feed is desired a Rotameter or a proportioning pump can be used, provided a predetermined temperature is maintained on the oil.

In the case of storage and handling of fatty acids, ordinary steel is not satisfactory. In such a case the storage tanks, pipe lines, valves, and pumps should be of stainless steel, aluminum, Duriron, or steel protected with a coating of lead, glass, or baked phenolic resin.

The finished lubricating grease, which is a plastic, was at one time discharged from the manufacturing kettle by gravity into containers set directly below the vessel. A large quick opening valve controlled the flow. Modern practice provides for forcing the finished grease through a strainer before packaging. Thus, even from an open vessel, as well as in a semi-continuous system, positive pressure is provided by a pump. The use of a pump has further advantages in that the lubricant can be discharged at some distance from the manufacturing system, either into storage, to a filling machine or to further processing equipment. In many cases portable pumps are set on a platform carried on castors and the inlet and outlet connections are rigged with quick action couplings carried on short lengths of flexible hose.

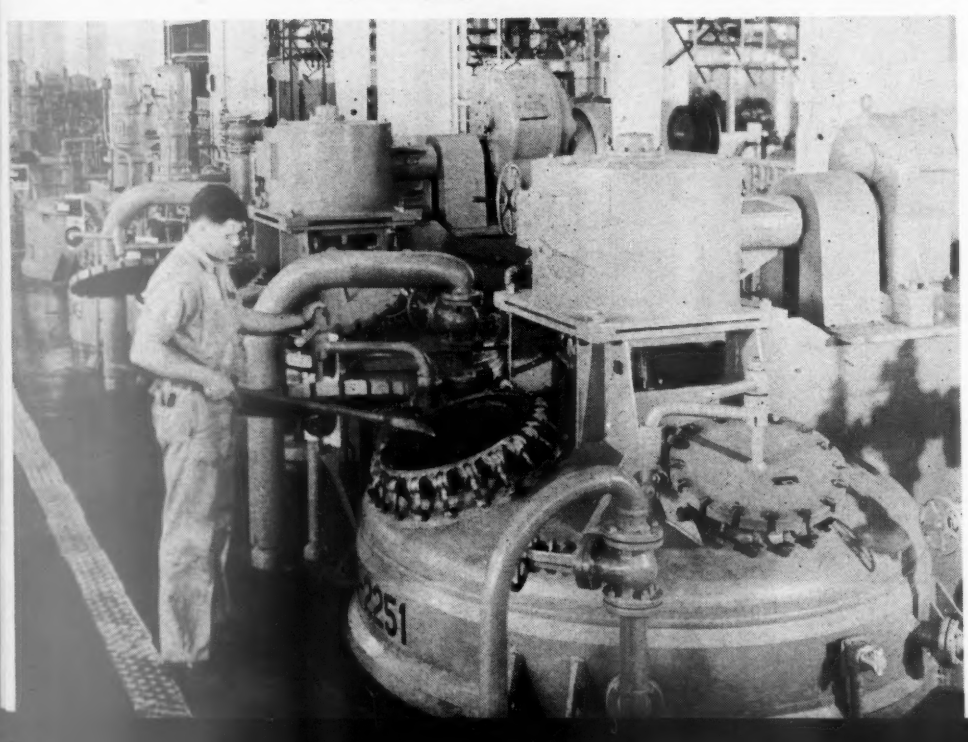
Both rotary and gear pumps are satisfactory for handling lubricating grease, 2- or 4-in. pumps being required. A 2-in. pump that will deliver 50 gpm of a fluid will deliver 20 to 30 gpm of a lubricating grease. A 2-in. pump for such service should be powered with a 5-hp motor, and a 4-in. pump will require a 15 or 20-hp motor.

Of course pumps normally are not direct-connected, and consequently it is possible to provide variable speed units. This is particularly desirable in case the lubricant is being discharged into various sized containers or in case the grease is being delivered to further processing. One plant has found that the cost of driving variable speed pumps, for filling packages, by air at 100 psig is justified because the initial investment was less than if variable speed motors had been installed.

Since screening is essential in modern lubricating grease plants the trend has been to provide self-cleaning screens or filters. Probably the most dependable device now in use is the Cuno, which consists of edge-spaced plates to catch dirt and undispersed soap particles. The usual spacing of plates for such service is .008 in. Cleaners that pass between the discs at the rate of 1 to 2½ rpm are actuated by a one-sixth horsepower motor.

Smaller packages of lubricating grease are filled with machines; the lubricating grease is pumped into a hopper from which plungers with a regulated stroke force a definite volume into a can. Some of these machines are rotary and others fill through a row of nipples.

FIG. 3. View of Autoclaves used in manufacture of lubricating grease. Taken on charging floor. —*Courtesy Standard Oil Company of California.*



Heat Transfer

As many of the oils handled in lubricating grease plants are of high

FIG. 4. Lubricating grease mixers—a removable concrete plug between the two vessels can be removed for installation of another kettle. —Courtesy Standard Oil Company of California.

viscosity, heating is required to enable them to be pumped easily. Many of the oils are used intermittently so provision is often made to heat only the portion of the oil to be pumped, rather than keep the entire tankful hot. For illustration, two suction heaters employing tube bundles were installed at the bottom of an outside storage tank. Each unit heats 40 gpm of an oil of 90 SSU viscosity at 210 F, from 30 to 140 F when supplied with 50 psig steam.

Certain types of lubricating greases require heats of 400 to 500 F for production. Older installations relied upon single shell, direct fired kettles to obtain such temperatures. Many such vessels are still in use, being heated by gas or oil burners.

More modern equipment consists of either jacketed vessels or closed systems employing steam, hot oil, or Dowtherm as heating mediums. One plant installed super-heated steam to obtain a processing temperature of 500 F but found the cost excessive. Newer jacketed vessels are built and tested for at least 150 to 200 psig steam.

The heat requirements for different types of lubricating greases vary, being greater for the ones in which soap is formed in the process and smaller for cases where preformed soap is employed. This is shown in Table 1, where the production of aluminum grease, from aluminum stearate and mineral oil, per 1000 lb of steam, is much higher than the production of calcium, barium, or calcium-sodium base greases.

Whatever the source of heat the production of soap from whole fats is accelerated by use of pressure vessels. In an open vessel the temperature of the contents remains little above the boiling point of water until most of the moisture has been removed. As some water is a prerequisite for hydrolysis, the reaction slows down, even though the heat rises, after the water is driven off. This then points to a closed vessel for saponification.

Such pressure vessels may take the form of the autoclaves shown in Figs. 3 and 4, which are equipped with double action paddles, the outer sweep being provided with adjustable and renewable spring steel scrapers. The first autoclaves installed in lubricating grease plants were made from cast iron so that relatively smooth surfaces could be provided for the action of such scrapers. With the advent of welded steel vessels such equipment has largely replaced cast iron.

TABLE 1.

Type of grease	Lb. of grease produced	Lb. of steam used	PSIG steam	Product per 1000 lb. steam
Calcium.....	7,500	1,800	100	4,166
Barium.....	10,000	3,200	100	3,125
Calcium and Sodium....	100,000	26,000	125	3,846
Aluminum...	.....	.....	100	8,870

One pressure vessel, the Stratco Contactor,[2] has an axial flow impeller, at the bottom, directly connected to a motor or turbine, which rapidly circulates and intimately mixes the saponification components. Circulation is upward through a narrow annular space between the outer jacketed shell and a double walled baffle and downward through the center of the unit. Heating medium is circulated through both the outer shell jacket and the double walled baffle to aid in rapid heat transfer. Saponification is said to be completed in 10 to 15 min when the temperature of the heating medium is in the order of 450 to 475 F. Application of this equipment is limited only by the viscosity of the reactants and diluents at the operating temperature.

The Stratco oil heating system is offered for use in conjunction with the above pressure vessel. This system, Fig. 4, consists of a small inside fired radiant section, a tubular convection

section, and a plate type air heater with forced draft gas or oil combustion. A high flash oil is used as a circulating medium and is heated to 450 to 500 F. An overall thermal efficiency of 85 to 90 per cent is claimed for this system. The heater needs no masonry and can, therefore, be either shut down instantly or fired up quickly. This heater is adapted to either semi-automatic or fully automatic firing control. One plant employing the above system manufactures lubricating grease without the benefit of a steam plant.

Even higher temperatures can be obtained by the use of a Dowtherm boiler and at the same time low pressures are maintained in the jacket of the vessel. One manufacturer has equipped a kettle producing a heavy bodied, high melting point lubricating grease with such a system and several experimental units for lubricating grease processing also use this heating medium.

One semi-continuous lubricating grease manufacturing process[3] employs Votators, Fig. 2, for both heating and cooling in a stream. This equipment consists of concentric cylinders about six feet in length with a rapidly moving shaft carrying scraper blades bearing against the inner wall of the central cylinder, through which a soap-oil mixture is forced. Beyond this wall is a chamber through which the heating medium travels. The blades remove the heated film from the heat transfer wall continuously and mix it violently with the remainder of the soap-oil mixture that is being forced through the length of the cylinder. An example of such an operation showed a throughput of 1740 lb per hour of a soap-oil mixture that was raised in temperature from 71 to 305 F employing steam at 100 psig.

Another semi-continuous process, Fig. 5, is in use for the production of calcium base lubricating grease.[4, 5] The soap-oil mixture is produced in retorts, heating and mixing being by recycling through a heat exchanger, which employs steam at 125 psig. In figuring heat requirements for such systems a specific heat of 0.6 is employed for soap-oil mixtures.

Normally lubricating grease can be cooled by the expedient of using cold oil added to a hot, heavy soap-oil mixture. However, it is frequently convenient to have cooling water connected to jacketed kettles so that reactions may be retarded or the finished product be delivered at a stated temperature.

The Votator is used for cooling grease, particularly aluminum base lubricating grease that is delivered to insulated tanks at a stated temperature range. In other cases a shock cooling is desirable and this may be accomplished by pumping into shallow pans or forcing through a wax chiller.

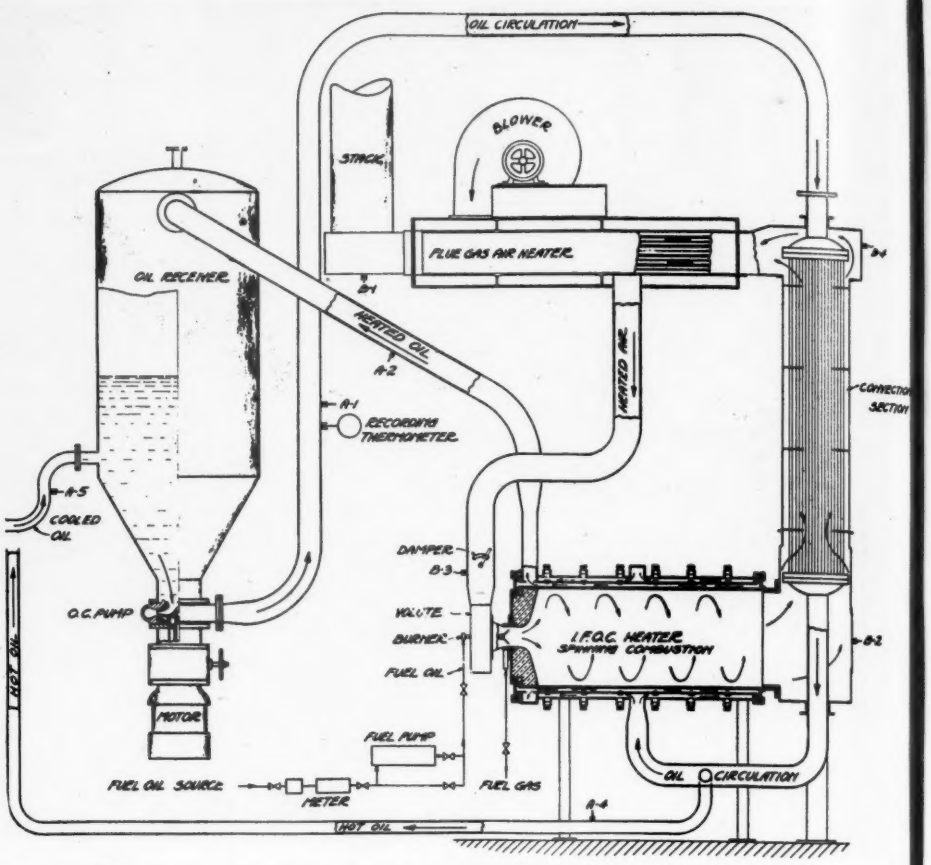


FIG. 5. STRATCO OIL CIRCULATION HEATING SYSTEM
Patents Issued and Pending

—Courtesy Stratford Engineering Corporation.

Mixing

As was noted above, heat is a contributing factor toward mixing during the manufacture of lubricating greases. Thus, the viscosity of most soap-oil systems decreases with increase in temperature and this in turn enables more rapid mixing. The normal method of mixing in batch processes is by paddle agitation, double action paddles being preferred. In some cases double motion can be simulated by having one set of stationary paddles and another set rotating.

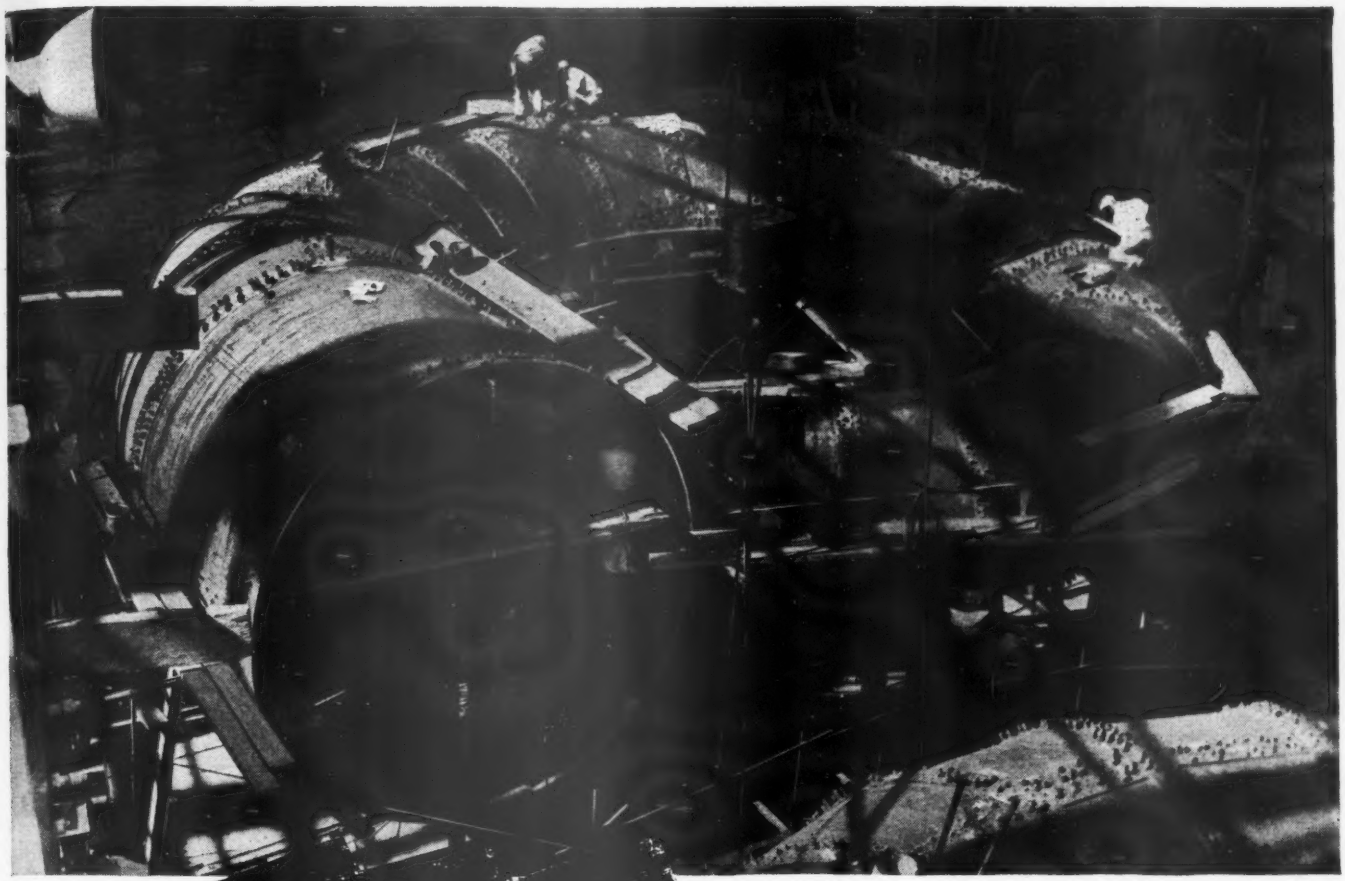
In batch processing, vessels of 40 to 75 bbl are most economical from both first cost and production standpoint. The larger kettles have agitators powered by 40 or 50-hp, two-speed motors. Thus, a 6 ft ID vessel holding 1900 gal has agitators driven by a 40-hp, 2-speed motor through a double motion drivehead that provides a speed of 22 and 11 rpm on the inner agitators and 14 and 7 rpm on the sweep. A 60-bbl kettle is in use with a fluid drive between a 40-hp motor and the agitators. This fluid coupling has prevented damage to agitators and gearing when the load became excessive, and no doubt the use of such a drive will be extended. One plant has been able to obtain four speeds on the agitators in small kettles by installing truck transmissions between motor and agitators.

Some plants supplement the agitation in kettles by using various types of pumps to circulate the contents of the kettles. Gear pumps probably do the best job of mixing. One plant even forces the lubricating grease being mixed through progressively smaller orifices.

Other semi-continuous lubricating grease manufacturing systems make use of high-speed mixers whose action is shear or turbulence of the ingredients. Thus, the Lancaster Disperser operates at 3600 rpm and recycles the mix while subjecting it to shearing action. Proportioning pumps may also be used for some mixing, particularly of cold-set products such as axle greases. In this case the two streams of ingredients leave the proportioning pumps with a swirling motion so that in a few feet of travel mixing is obtained and the soap is formed.

Dehydration

If saponification or processing is carried on in an open vessel at elevated



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temperatures the water is removed gradually. If saponification is carried out under pressure, release of this pressure while the charge is still hot will flash off the water. In fact, some plants exhaust the pressure cooker into an open finishing kettle and permit the water to escape during this procedure.

In the manufacture of lubricating grease from pre-formed soap such as aluminum stearate, it is desirable to remove any moisture present before the soap-oil mix has formed a grease structure. This moisture removal is by subjecting a slurry of the oil and soap to vacuum. In one semi-continuous process this is done by subjecting small batches to vacuum in a slurry-tank at room temperature. In another system the slurry is heated to 150 F and then introduced at the center of a rapidly rotating disc (Fig. 1), over which it passes in a thin film while being subjected to vacuum.

Milling

Only a small proportion of the total lubricating grease produced is subjected to milling, but equipment for this purpose is becoming increasingly important and is probably the subject of more present development than any other type of lubricating grease manufacturing equipment.

The first milling of lubricating greases was done by the use of stone burr mills and recently two lubricating grease plants have installed such improved mills of a high speed type that will handle up to 4000 lb per hour, each. Both steel and carborundum plates are being tested on these mills.

Most of the modern mills depend upon shear at high rates to reduce the fiber length of the lubricating grease. Some plants have installed colloid mills, not only for this purpose, but also to disperse fine fillers in the lubricant. At present, information is withheld as to details of operation and results obtained.

Certain lubricating grease bases are now available that can be dispersed mechanically in mineral oil to produce grease-like structures. Either colloid or paint mills are recommended for this purpose. The paint mills employed are roll mills and of course do not have large capacity. A high speed stone mill, running at 3600 rpm is said to be the answer.

Vacuum Treatment

Much of the lubricating grease produced in agitated kettles has considerable entrained air. If the finished product is transparent or translucent, as are many of the present premium lubricating greases, such air detracts markedly from the appearance. Further, this air may even be detrimental to the storage and use of the lubricant. Consequently, many plants subject all of their premium products to vacuum to remove entrained air.

This vacuum treatment may be by batch or by continuous methods. In the batch process a vessel that will hold from 2000 to 4000 lb of grease is half filled, and then a vacuum of about 28 in. drawn. In some cases the vacuum chamber will have agitation that will help to break the air bubbles. After full vacuum is reached, the vessel is exhausted and the grease removed.

Use of a continuous process is of course more satisfactory and all modern installations are of this type. One process, see Fig. 1, pumps the lubricating grease to the center of a spinning disc where it is thrown outward in a thin film. A vacuum pipe takes off at the center and a scoop picks the lubricating grease up by suction of a pump, the scoop being situated at the outer curved edge of the disc. As long as the centrifugal force is sufficiently high no lubricating grease will be pulled out through the vacuum line. The disc revolves at 900 to 1800 rpm.

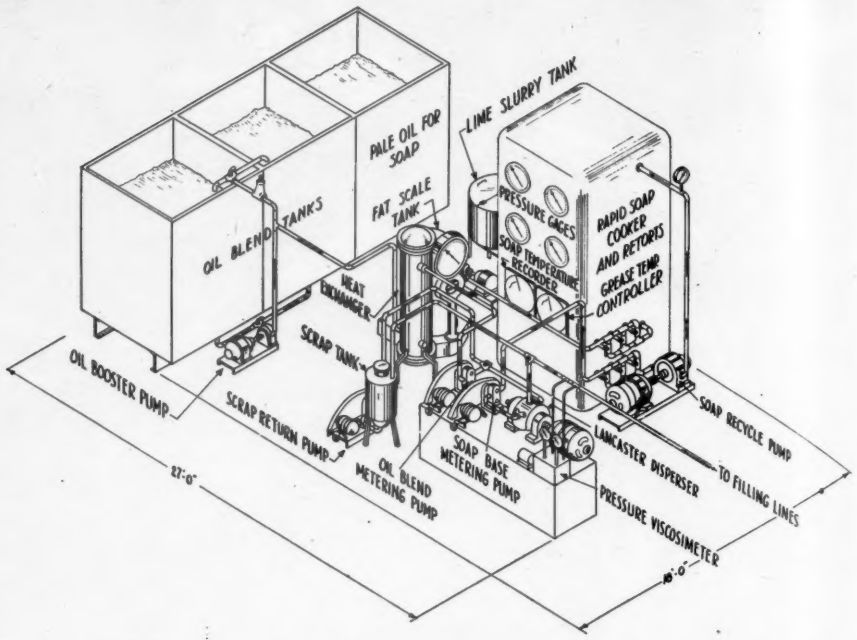

FIG. 6. Isometric view of equipment for Esso continuous process of lubricating grease manufacture. —*Courtesy The Girdler Corporation.*

Miscellaneous Equipment

Indicating, control, and regulating equipment employed in connection with lubricating grease processing is in line with that installed in most modern plants so only special devices that have been found of value will be mentioned.

On one processing kettle, devoted to the manufacture of a lubricating grease that goes through a very heavy stage, an ammeter has been found of value. The operator depends upon the reading of this instrument to determine the stage of reaction.

In a semi-continuous process,[5] Fig. 6, a pressure viscosimeter is used to measure the consistency of the stream of lubricating grease. A continuous stream of the product is taken off from the main stream by a sample line and delivered to a positive displacement pump driven by a constant speed motor. This pump forces the lubricating grease through a capillary. Both the pump and the capillary are immersed in a thermostatically controlled oil bath so that measurement is at a constant temperature.

The pressure drop through the capillary is measured by means of two diaphragm strain gages, the resistance of which are measured electronically, automatically subtracted and recorded. For the operating conditions and capillary dimensions employed, the correlation between the ASTM worked penetration and the pressure drop through the capillary tube has been determined. Any change in oil viscosity, viscosity index, or titer of the fat, requires new correlations.

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* * *

Application of Automatic Control

Choice of Type of Instrument Is Dictated Operating Conditions and Nature of Problem

A. M. PLATT* and G. L. FARRAR*

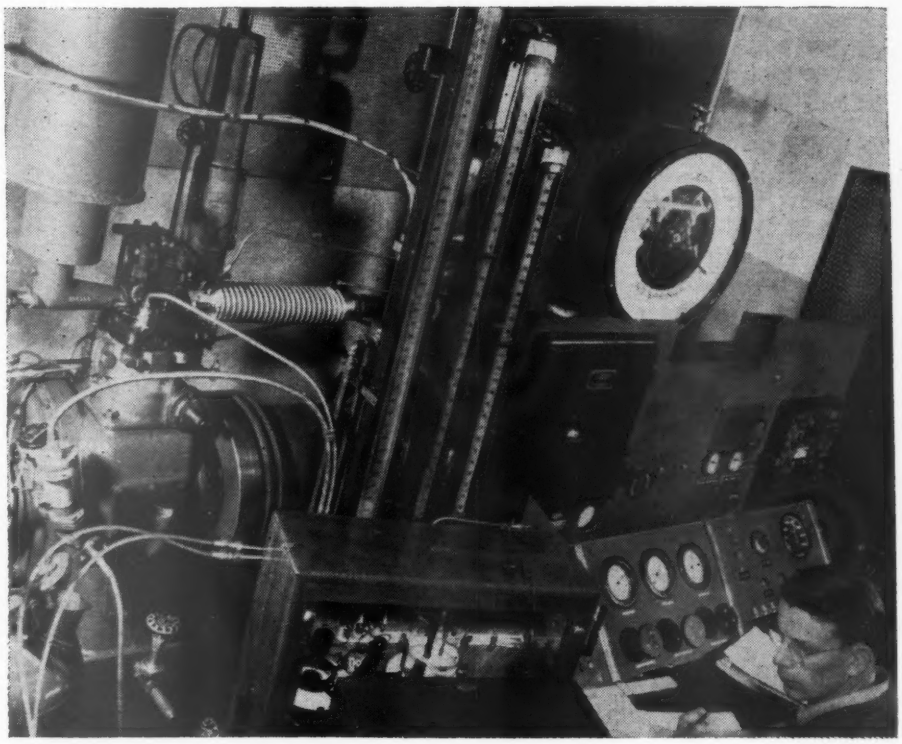
PART 1

THE principles of instrument selection are not extremely complicated, yet these principles are either unknown to, or are not understood by, a large number of technical and operating men who are not primarily engaged in instrumentation work. It is the purpose of this presentation to outline some of the general principles of selection of automatic controllers. This will be accomplished by first examining the various automatic control modes (types of controller responses in answer to a given change in process variable). The characteristics of certain typical processes will next be investigated, and matching of control mode with a given process, in light of the control requirements, will complete the presentation. Due to limitations of time and space the scope of this paper will be concerned with controller application. Selection and use of measuring elements, final control elements, transmission of measurement, etc., will necessarily be omitted.

The choice of a pneumatic or an electrical instrument is based on several considerations. Installation for electrical operation is simpler than for pneumatic. In general the electrically-operated controller is more easily and simply constructed, when using the less complicated modes of control. For the more complicated modes of control, construction for pneumatic operation is simpler. If the installation is made in an area where explosive mixtures may be encountered, it is customary to "play safe" and use a pneumatic instrument. In any event, these and other factors must be considered. The choice will then depend on the individual requirements of the given situation.

An automatic controller is an indicating controller if the level of the controlled variable is continuously indicated, but no permanent record is produced. At a very nominal cost, a recording controller may be specified instead of an indicating instrument, the only extra equipment being a clock and pen assembly. Charts and graphs must be supplied for recording controllers, however, and storage space must be available for the completed record. This latter item becomes an important factor when a large number of controllers are involved.

FOR some installations a recording instrument is absolutely necessary. Average flow rates and total consumption are often required in natural gas sales and transportation work. In installations where precise control is essential and where it is desired that magnitudes and times of deviations be correlated against product yield and quality, a recording instrument is highly desirable. When the control installation requirements are such that good control is necessary, but small deviations are of no appreciable consequence, an indicating controller is entirely satisfactory.



Single cylinder aircraft test engine with unusual set of control instruments in The Texas Company's Beacon, New York, laboratories.

Modes of Automatic Control

Operation of an automatic control system depends on transmission of an impulse (electrical or pneumatic) from a measuring element to the controller, response by the controller, and actuation of the final control device (usually a valve). The type of response by the controller to a given change in process variable is termed, mode of control. The modes of control to be considered here are two-position (on-off), proportional (throttling), floating, and combination modes.

The two-position mode operates so that the valve is rapidly positioned to the full open or closed position when the level of the process variable (such as temperature, pressure, liquid level, fluid flow, etc.) reaches a certain point. If an oil stream is passing

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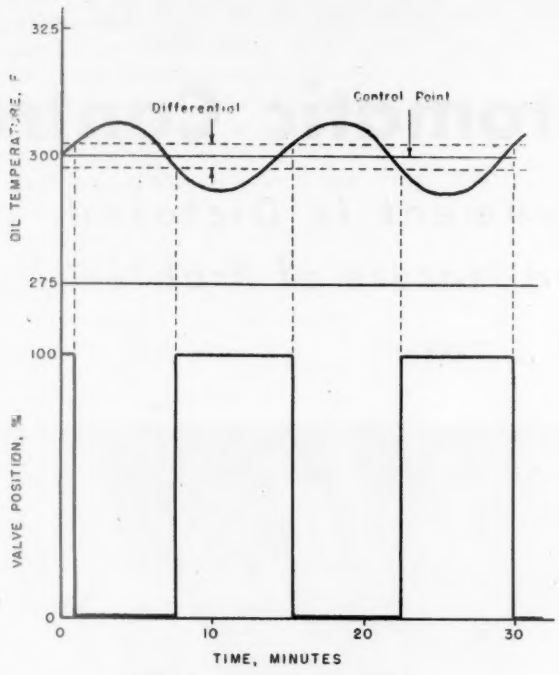


FIG. 1. Two-position mode.

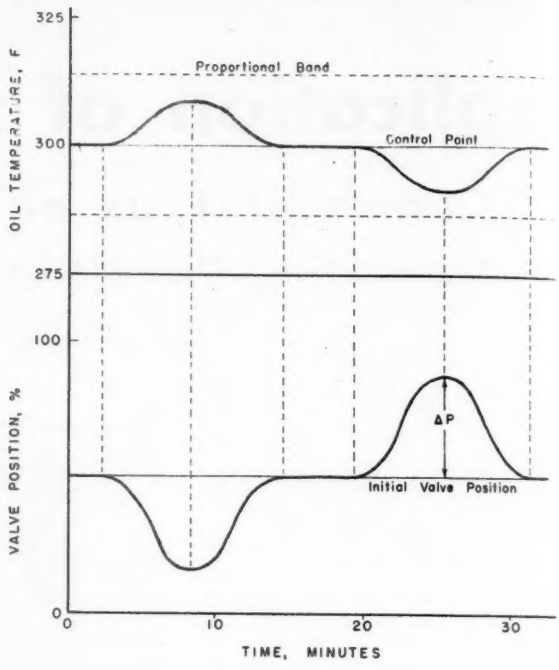


FIG. 2. Proportional mode.

through a steam-heated exchanger, with the temperature of the effluent oil being controlled by adjusting the steam rate with two-position controller, the valve will be completely open when the exit oil temperature is below the desired control point. Likewise the valve will be closed and the steam supply will be cut off when the exit oil temperature is above the control point. Ordinarily, a two-position controller is built with a differential, meaning that the control valve will remain in a given position until the controlled variable moves slightly past the control point. The relationships between valve position and level of the variable are shown in Fig. 1. It is seen (this point will be discussed in detail under the heading, "Process Characteristics") that a comparatively wide fluctuation in temperature will result if the two-position control mode is used. This may or may not be a disadvantage, depending on the allowable deviation in the effluent temperature.

The proportional or throttling mode of control is defined such that the change in valve position is directly proportional to the deviation of the controlled variable from the control point. This relationship may be more clearly indicated by the equation,

(1)

$$-\Delta P = K_p (\Theta - C),$$

ΔP = Change in valve position, fraction of full valve travel,
Θ = Level of controlled variable, fraction of controller scale,
C = Control point, fraction of controller scale.
K_p = Proportionality constant.

The proportionality constant, K_p, is equal to $1/s$, where s is defined as the proportional band width, or throttling range. The numerical value of s gives the fraction of controller scale traversed by the controlled variable while the valve moves from complete open to complete close. The minus sign is used to indicate that the valve moves to counteract the change in controlled variable.

In presenting equations for the various control modes, both the form of the equations and nomenclature therein are very similar to those of Eckman.[1] It is felt that equations of this form are adequate; yet they are simple, showing the valve-controller relationships. The nomenclature is based on standards set up by the various technical societies concerned with instrumentation.

In considering proportional band, note that a small value for s (narrow band) will result in a relatively large valve movement. Conversely, a large value for s (wide band) will result in a relatively small valve movement. The proportional band is adjusted to as narrow a value as possible, without upsetting the system. If the band is too narrow, the valve tends to "over correct", and considerable cycling of controlled variable response results.

The rate of change of valve position for the proportional mode may be determined by differentiating equation (1) with respect to time, t.

(2)

$$-dP/dt = 1/s\ d\Theta/dt,$$

dP/dt = Rate of change of valve position.
$d\Theta/dt$ = Rate of change of controlled variable.

With the proportional mode of control, a correction (change in valve position), which is a direct function of the amount of deviation, is applied. This behavior is shown in Fig. 2. In this figure, the exit oil temperature from a steam-heated exchanger and the corresponding valve position are again plotted as functions of time, and the valve position corresponding to a given controlled variable deviation is readily determined. In this figure, as opposed to Fig. 1, the change in oil temperature is shown as a gradual change, with the oil reaching a maximum and then lining out at the control point. This type change is later repeated with a decreasing temperature. Eckman[1] calls this a "stable" change. This type of change is rarely encountered as such in actual control problems, but it is representative of certain parts of change cycles. It is used as an example to illustrate the action of this and subsequent modes in response to a given change. Thus a comparison of the responses caused by the various modes is afforded. Once the mode characteristics are understood, application can then be made easily to any type of change.

The disadvange of the proportional mode is that there is a specific valve position for any given level of the process variable. Thus, if there is appreciable load change, it is not possible to maintain the original control point. This point will be expanded in the section on process characteristics.

In order to maintain precise control at a given control point when appreciable load changes may be encountered, a floating mode is used. In general the defining characteristic of a floating mode is that the valve moves continuously as long as the level of the variable is not at the control point. The simplest floating mode is the single speed floating. When using this mode, the rate of change of valve position is a constant quantity, whenever the level of the variable deviates from the control point. Or,

$$(3) \qquad -dP/dt = K_f$$

The disadvantage of this mode is that there is no recognition of magnitude of deviation, only the fact that some deviation does exist. The single speed floating mode may be used with a neutral zone. This is a small region on either side of the control point in which there is no change in valve position. Thus the neutral has a stabilizing effect on controlled variable deviation.

It is possible to use a multi-speed floating mode of control to recognize in some measure the magnitude of deviation of the controlled variable. In this mode there is a sudden increase in rate of change of valve movement when a certain value of deviation is reached. However, the most satisfactory way to compensate for magnitude of deviation when using a floating mode is the use of the proportional-speed floating mode. This mode is defined such that the rate of change of valve position is proportional to the deviation of the controlled variable from the control point:

$$(4) \qquad -dP/dt = K_f\,(\Theta - C),$$

K_f = The floating rate of the valve.

The equation for change in valve position may be obtained by integrating Equation (4),

$$(5) \quad -\Delta P = K_f \int_0^t (\Theta - C)\,dt$$

Thus it is seen that $(\Theta - C)$ must be known as a function of time before change in valve position can be evaluated. The relationship between level of the controlled variable and valve position is shown in Fig. 3. Here again the exit oil temperature from a steam-heated exchanger is plotted as the controlled variable. As may be seen the proportional-speed floating mode has the advantage of being able to return the controlled variable to the control point after a load change, and it recognizes proportionally the magnitude of deviation of the variable. The disadvantage of this mode is that compensation for a change is necessarily slow, and it is not possible to provide adequate compensation for sudden changes in controlled variable.

It is readily seen that the proportional and proportional-speed floating modes have distinct advantages in control applications. Also each has disadvantages associated with it. Thus, a mode of control that could utilize the advantages of each would have great utility. Quick correction in proportion to the deviation of controlled variable, plus continuing correction as long as the variable remains away from the control point would thus be afforded. It is possible to join these characteristics into a combined mode. The responses are algebraically additive, so that maximum benefit results when the rates and magnitudes of the responses are adjusted to each other. It is beyond the scope of this article to dwell at length on the factors that influence these various settings, or the adjustment of controller responses in actual application. Suffice it to say that the correct responses can be obtained, and the ensuing discussion will be based on the assumption that optimum settings have been ascertained.

The combination mode described is known as the proportional-reset mode of control, or it may be called throttling with automatic reset. The term, "reset", is used, as it is the function of this mode to move the valve to a new position while the variable is returning to control point. It will be recalled that this repositioning action (reset) may not be obtained from proportional control alone, due to the very nature of its action. As the individual responses of each mode may be added algebraically to determine the combined response, it follows that the equations for change in valve position and rate of change of valve position are additive. Thus,

$$(6) \quad -\Delta P = K_{pr} \int_0^t (\Theta - C)\,dt + 1/s\,(\Theta - C),$$

FIG. 3. Proportional-speed floating mode.

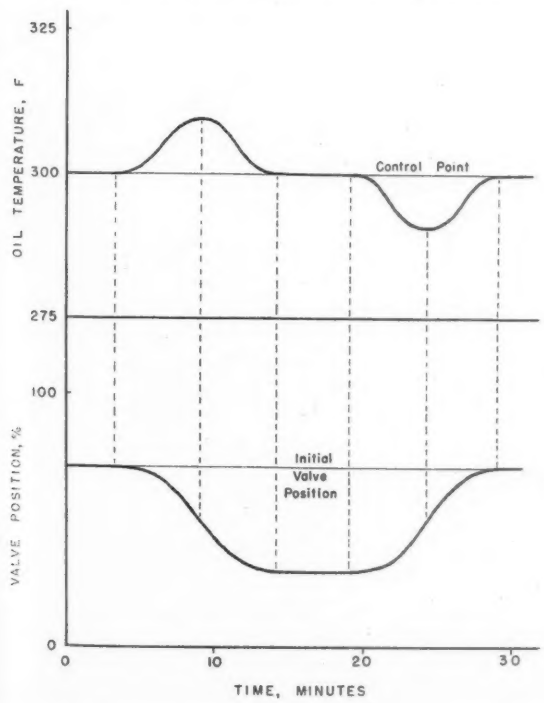
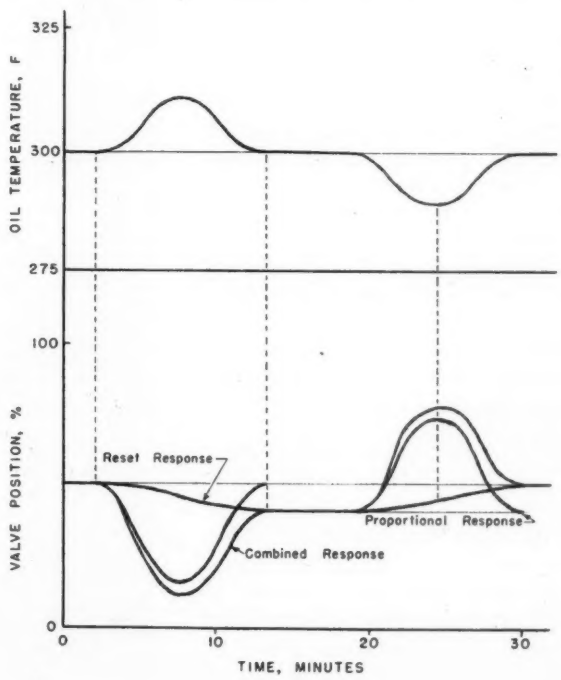


FIG. 4. Proportional-reset mode.



from Equations (1) and (5). Also,

(7) $-dP/dt = K_{pr}(\Theta - C) + 1/s\, d\Theta/dt$,

adding Equations (2) and (4).

For the proportional-reset mode, the proportionality factor, K_{pr}, is made up of two different terms and is defined as a ratio of them: $K_{pr} = \frac{r}{s}$.

Here again *s* is the width of the proportional band, while *r* is defined as the number of times per minute that the proportional response is duplicated by the reset response. Thus this mode is made even more versatile, in that the floating rate of the reset response is defined in terms of proportional band width and definitely linked with it in the construction of the controller.

Again consider the problem of controlling the effluent oil temperature from a steam-heated exchanger. The response of the controller, as indicated by valve position corresponding to a given deviation of controlled variable from the control point, is shown in Fig. 4. The change in controlled variable is again assumed to be "stable". In this diagram the responses due to the individual modes are also shown, in order to emphasize their relationships to each other and to the combined response. It is readily seen that the return to control point is the result of both actions. The time and amount of controlled variable deviation are limited mainly by the proportional mode, while the resetting of the valve (at control point) is due to the reset mode alone.

Perhaps the factors that contribute most to lowering the quality and precision of automatic control are lag and dead time. It is not desirable at this point to define these terms completely and to examine all their ramifications. Suffice it to say that lag is the time ensuing between the time when a certain level of the process variable occurs and the time when that level of variable is indicated at the controller (on the controller record, or on the indicating device). Dead time is the time elapsed between the time when a variable deviation begins and the time when the measuring system first indicates that change at the controller. It is readily seen that the quality of control attainable decreases progressively as lag and dead time increase in a given process. Thus, it is both necessary and desirable to include some mode or response that will reduce the deleterious effect of these two factors. The mode that is used to accomplish this purpose is known as the rate, derivative, or preact mode. It is defined as the response in which change in valve position is proportional to the rate of change of the process variable. Or:

(8) $-\Delta P = K_r\, d\Theta/dt$

Differentiation of this equation will show the relationship between rate of change of valve position and variation of controlled variable:

(9) $-dp/dt = K_r\, d^2\Theta/dt^2$

The factor, K_r, is defined as q/s, where *q* is rate time in minutes and is a measure of the time lead of the valve due to rate response. By addition of rate response, the valve is enabled to attain a given position sooner than would otherwise be possible. The reason for this action is shown in Fig. 5, where valve response due to rate action alone is plotted as a function of the change in process variable. The effluent oil temperature from a steam-heated exchanger is again chosen as the pertinent process variable. In order to better understand the mechanism of rate response, the valve position and variable curves of Fig. 5 will be analyzed in terms of Equations (8) and (9). Note from Equation (8) that the net change in valve position is zero at the maximum level of the controlled variable (the point where $d\Theta/dt = 0$). Note also from Equation (9) that the rate of change of valve position is zero where the second derivative of the controlled variable, with respect to time, is zero (inflection point). This corresponds first to a minimum point and then to a maximum point on the valve position curve. Note again that when the variable is on control point after the change has occurred, there can be no net change in valve position. Thus the change in valve position due to rate action is a transient effect, occurring only when the controlled variable is changing. From inspection of the valve and variable curves, it is seen that the valve leads the *recorded* variable. It should be pointed out that the valve does not lead the actual variable, but that the measuring lag and dead time have to some extent been nullified.

As seen from the foregoing discussion the characteristics of the rate mode are such that it is never used alone, but in combination with other modes. It is used with the proportional mode to give proportional-rate response. This mode is of use when load changes are not great, but where lag and dead time are appreciable.

Where significant load changes can occur and where lag and dead time are appreciable, the proportional-reset-rate mode of control may be used. This mode is also called throttling control, with automatic reset and derivative action. Again using the example of control of exit oil temperature from a steam-heated exchanger, Fig. 6 is plotted to show the valve response to a given change in oil temperature. The responses due to each individual mode in the combined action are also shown in order to emphasize the effects (and characteristic action) of each. The effects are again additive, as seen in Fig. 6. Thus the equations

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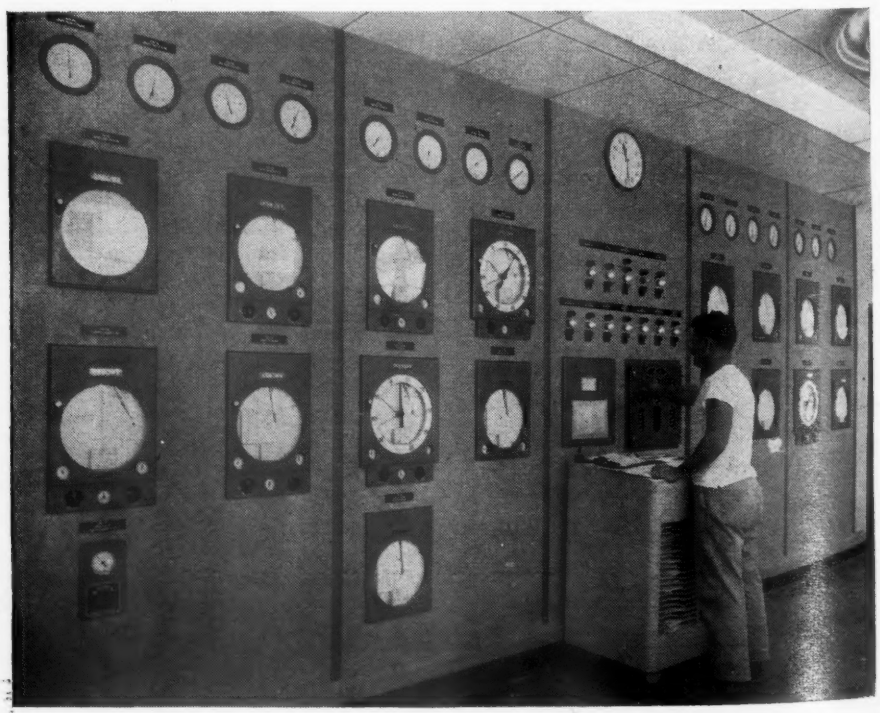

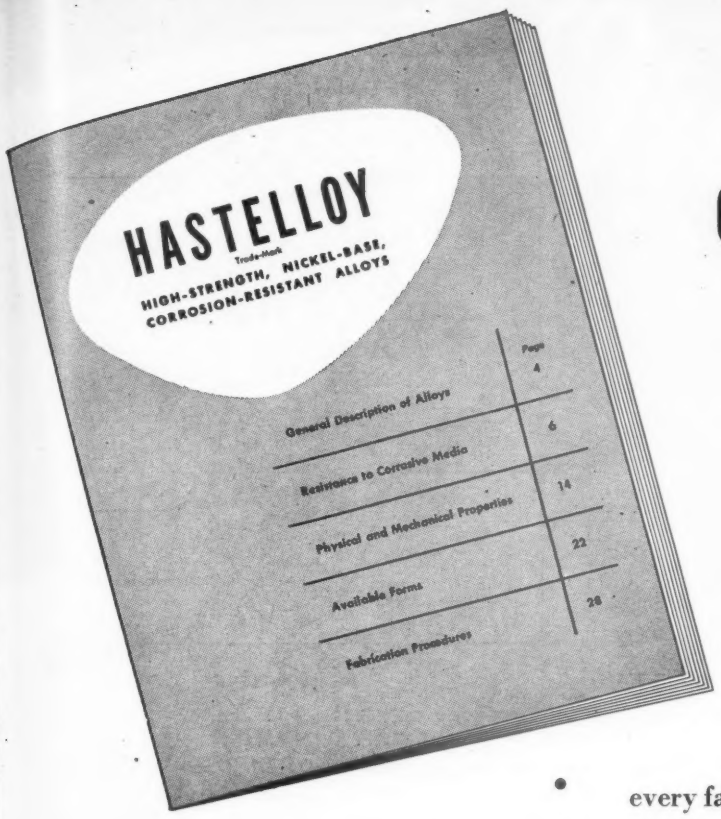

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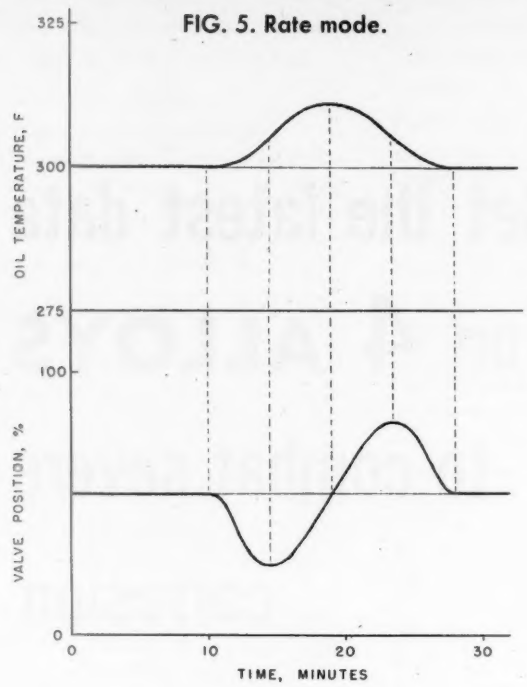

FIG. 5. Rate mode.

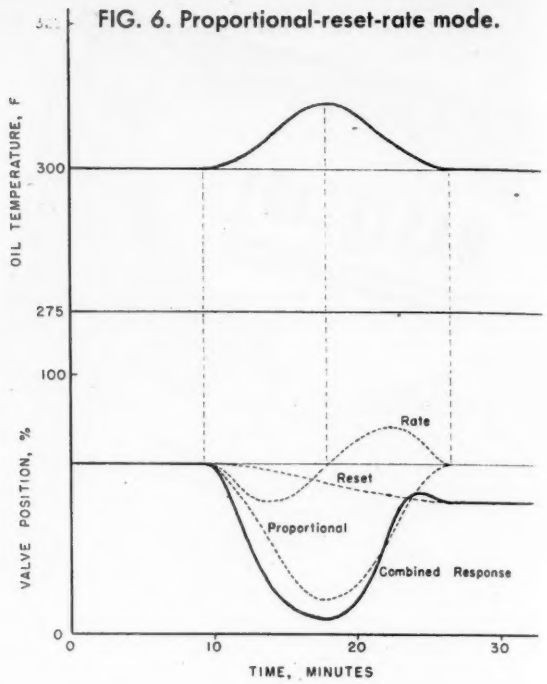

FIG. 6. Proportional-reset-rate mode.

for change in valve position and rate of change of valve position are as follows:

(10)

$$-\Delta P = r/s \int_0^t (\Theta - C)\, dt + 1/s\,(\Theta - C) + q/s\, d\Theta/dt$$

(11) $$-dP/dt = r/s\,(\Theta - C) + 1/s\, d\Theta/dt + q/s\, d^2\Theta/dt^2$$

In order to further explain the nature of Equations (10) and (11), as well as the other equations previously presented, two example problems are worked out below.

Example 1. A pressure is increasing at the rate of 7.5 psi per minute. The controller scale limits are 0 to 300 psig, and the control point is 150 psig. Using a proportional-reset-rate controller, calculate the change in valve position and the instantaneous rate of change of valve position three minutes after the change in pressure begins. Controller settings are: r = 0.05; s = 0.25; q = 0.4.

Solution:

$(\Theta - C) = 7.5\ t/300 = 0.025\ t$

$d\Theta/dt = 0.025$

$d^2\Theta/dt^2 = 0$

$$-\Delta P = 0.05/0.25 \int_0^3 0.025\ t\ dt + dt + 1/0.25\ (7.5 \times 3/300) + 0.4 \times 0.025/0.25$$

$-\Delta P = 0.20\ [0.025\ t^2/2]_0^3 + 0.3000 + 0.0400$

$-\Delta P = 0.3625$

Therefore, the valve has moved through 36.25 per cent of its travel, and is opening to relieve the pressure.

$-dP/dt = 0.05/0.25 \times (7.5 \times 3/300) + 1/0.25\ (0.025) + 0$

$-dP/dt = 0.015 + 0.100 = 0.115$

The valve is moving at a rate of 11.5 per cent of its travel per minute, at the end of 3 min.

Example 2. The exit temperature from a heater is cycling in a sinusoidal manner, such that the temperature varies from 147 to 153 F. The controller scale limits are 100 and 200 F, and the control point is 150 F. The period (time for one complete cycle) is four minutes. Using a proportional-reset-rate controller, calculate the change in valve position and rate of change of valve position one minute after the temperature rises above the control point. Settings are: r = 0.07; s = 0.3; q = 0.5

Solution:

Amplitude $= 53 - 50 = 3$ F $= 3/100 = 0.03$

Period $= b = 4$ minutes

$\Theta - C = 0.03 \sin 2\pi\ t/4 = 0.03 \sin \pi\ t/2$

$d\Theta\ dt = \pi/2\ (0.03 \cos \pi\ t/2)$

$d^2\Theta/dt^2 = -\pi^2/4\,(0.03 \sin \pi t/2)$

$\sin \pi\ t/2\ dt = -2/\pi \cos \pi\ t/2$

$$-\Delta P = 0.07/0.30 \int_0^1 0.03 \sin \pi\ t/2\ t/2\ dt + 1/0.30\ (0.03 \sin \pi/2) + 0.5/0.3\ (\pi/2)\ (0.03 \cos \pi/2)$$

$-\Delta P = 0.07\ [2/\pi) \cos \pi\ t/2]_0^1 + 0.100 + 0$

$-\Delta P = 0.0046 + 0.100 = 0.104$

The valve has closed 10.4 per cent of its travel in one minute.

$-dP/dt = 0.07/0.30\ (0.03 \sin \pi/2) + 1/0.30\ (\pi/2)\ (0.03 \cos \pi/2) + 0.50/0.30\ [(-\pi^2/4)\ (0.03 \sin \pi/2)]$

$-dP/dt = 0.007 + 0 + (-0.123) = -0.116$

At the end of one minute, the valve is *opening* (note the negative sign) at the rate of 11.6 per cent of its travel per minute. Thus, the valve is opening to admit heating medium, even though the temperature is above control point. The valve is leading the recorded variable.

The changes in controlled variables in any oil refining or natural gasoline process will seldom if ever be such that an equation can be accurately fitted to the controlled variable curve. This does not, however, reduce the value of the previous analysis and problem examples. Once the equations and characteristics associated with each mode are understood, the qualitative (and to some extent, certain quantitative) relationships between level of controlled variable and valve position will be understood. Based on process characteristics (discussed below) and a knowledge of the behavior associated with each control mode, it is possible to make intelligent selection of control mode. * * *

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CHEMICAL CLEANING

VINCENT E. BOWES*

Modern Methods for Cleaning Refining Equipment—Including Heat Exchangers—Reduced to a Science.

OPERATING costs are still on the rise. This continuing condition has led into many possible avenues of economy. Cleaning refinery equipment with chemical cleaning materials using equipment fabricated in the refinery shops has been an outstanding development in this search for worthwhile economy in refinery maintenance work. This way the planning for and completing the job is done by those who know the conditions best—the refinery personnel themselves, instructed by special service representatives of the manufacturer of the cleaning materials used.

Recent work on these methods at many refineries, particularly on heat exchanger cleaning work, has created great interest. The development now perfected consists of circulating chemical cleaning materials through the shell and tube sides; or immersing the pulled tube bundle in a tank of a specialized cleaning solution. The equipment needed for this work can be fabricated by the refinery personnel themselves. There are three main classifications of equipment used: Permanent or temporary equipment for cleaning banks of exchangers in place; mobile equipment that is rolled into place whenever cleaning is needed; and stationary equipment used to clean exchanger bundles in tank immersion methods. In all these methods, one fact stands out with clarity: Regular cleaning of heat exchangers is one of the simplest, most economical ways of keeping heat exchangers at peak efficiency, and putting equipment back on stream with a minimum of downtime.

The information in this article about refinery personnel using chemical materials for simplified, fast cleaning of heat exchangers is given as a possible source of clues to improvement in refinery operation.

*Manager, Petroleum Service Division, Oakite Products, Inc.

Importance of Clean Exchangers

That cleaning heat exchangers is important is recognized everywhere. Fuel costs mount and units generally perform badly if they are not maintained in a clean condition. If they are cleaned regularly, the pump pressure stays at the proper reading; heat transfer is far more efficient, and a better cut is obtained from the fractionating process. Removing the hampering petroleum based deposits from surfaces of the exchanger tubes and removing the water scale from other surfaces removes the big block to efficient heat exchanger operation. But the immediate problem is how to do it at minimum cost and with a minimum of equipment downtime. The strides made by chemical material manufacturers in developing the materials and methods that the refinery can put to work themselves are a solution to the problem.

In using these methods the results have proved that the degree of an exchanger's efficiency is usually in direct ratio to the degree of its cleanliness. But not all heat exchangers require the same amount of cleaning for best performance. The kind of equipment, nature of the soil and its placement, the quantity of replacement bundles, the production schedule—all these effect the way the program is finally worked out for cleaning by circulating a chemical material through the heat exchangers. The desired low operating costs are usually to be obtained by fitting the cleaning material and method to the particular cleaning problem of the exchanger or group of exchangers. However, the cost of cleaning must be balanced against the end results. All this calls for specialized advice.

That is why it is generally good practice to use refinery personnel and the counsel of cleaning materials manufacturers to place the best cleaning effort where it is most needed. That combination makes for the kind of specialized and highly efficient, economical cleaning that stands head and shoulders over other methods.

The methods that have been developed to clean heat exchangers with chemical cleaning compounds generally come into one of the following classifications:

1. Cleaning one or a bank of heat exchangers hooked into the tower by circulation of a chemical cleaning material. Permanent, temporary, or mobile equipment may be used for this work.
2. Cleaning one or a bank of isolated heat exchangers by circulation of a chemical cleaning compound. Same equipment as above.
3. Cleaning pulled tube bundles of heat exchangers by immersing them in a tank of a specialized chemical cleaning material.

Regular Cleaning Program Advisable

The advantages to be gained by cleaning heat exchangers are based on the premise that cleaning will be performed regularly. Such a program minimizes the big troubles that arise when cleaning is performed only if conditions become so bad that pumps cannot handle the pressure requirements, or when heat transfer readings are very low. The deposits causing these poor results should be removed regularly so that the work can be done in less time, with greater effectiveness.

Therefore a regular cleaning program should be set up. Pressure surveys and heat transfer surveys may be initiated and carefully performed in conjunction with the helpful guidance of a technical service representative of the cleaning material manufacturer. These surveys will help to determine which units in the system require cleaning more frequently than others. Once standardized, the cleaning and descaling procedures will prove to be highly economical because circulation time will be considerably reduced as will the amount of chemical material used for circulation cleaning procedures.

This planning ahead also enables the maintenance department to schedule ahead in the use of men and equipment. It makes possible scheduling

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equipment already in the yard for use on the job. It also allows enough time for maintenance personnel to fabricate the necessary equipment—equipment that will then be used repeatedly for circulation cleaning. It has been found that once the program is set up all the data may be conveniently charted for helpful reference on forms like the one in Fig. 1. These include: The facts about this equipment and the chemical cleaning materials used, the temperatures at which they were used, the kind of deposit and the temperature at which it formed, the length of time the unit was out of service for cleaning, and the kind of product being processed.

Make-up of Deposits to be Removed

Setting up suggested cleaning program surveys requires a knowledge of the deposits most often encountered in heat exchangers. Depending on the exchange media: Oil to oil, oil to vapor, and oil to water, vapor to water, etc., the deposits to be removed are two general classes: Petroleum-based deposits and water scale deposits. The petroleum-based category may range from those that have a high carbon and low oil content, including tar and asphalt deposits. These are found on either the shell or tube side, or on both. On the tube side, varieties of water scale may form. But whatever the inner and outer deposits consist of, the important thing is that they cut down heat transfer and increase pump pressure, which means operating at reduced efficiency. All of these deposits must be removed thoroughly and in a short time to put the heat exchanger back into service at its peak operating efficiency.

Kinds of Deposits

Visual and in many cases chemical examination of the deposits that have formed on processing equipment surfaces will help to determine the selection of the proper cleaning material to use for cleaning the exchanger. The characteristics of these fouling substances, their thickness and adhesive properties, will go a long way toward determining the temperature and the selection of the method by which cleaning is to be performed. This is especially true of different exchangers in the bank. Adjoining exchangers might easily have different deposits all of which require different kinds of cleaning materials or different combination of cleaning materials. Deposits may also vary from one processing cycle to the next and from one refinery to another. But for test purposes, it is well to select sample deposits from different points in the heat exchange system as they are related to its position in the processing system, the temperature at which the deposits have built up, and many other factors.

In general it can be said that any deposits on the exteriors of tube surfaces form an insulation that retards the flow of heat through the walls of the tubes. Bulk deposits will interfere with the full capacity flow of the liquids through the equipment. Their weight and clogging nature usually require that pumps be operated at higher pressure to force the liquids through. The presence of water scale is common in many types of heat exchangers. Water scale in most instances is composed of magnesium and calcium compounds and other impurities frequently found in water. The degree of scale that settles on the surface depends on both the characteristics of the water and the conditions under which that water is used. Once the nature and amount of the water scale is determined chemically, the cleaning material and strength needed to remove it may be determined. This ends the big block to efficient heat transfer.

It is not difficult to learn about the characteristics of the deposits that form on heat exchanger bundles. Most of the typical deposits have long ago been analyzed and charted. The information regarding them and the chemical cleaning material that will remove them with the greatest dispatch is available from the manufacturer of chemical cleaners.

Cleaning Materials to be Used

In most cases, the petroleum based deposits built up in processing sweet crudes are most effectively removed by using a water-soluble cleaning material that has the ability to emulsify and disintegrate those deposits. That emulsification and disintegrating action disperses deposits of oily and waxy makeup through the solution and prevents their re-deposition on surfaces. This property is incorporated in an alkaline cleaning material that also has the ability to penetrate the deposits quickly and to suspend them in the solution.

Where sour crudes or a mixture of crudes are processed, or where cleaning has been infrequent, certain deposits build up in the equipment. Often these deposits appear to be coke or carbon; actually there may also be considerable percentages of either sulfides or oxides that usually yield to the action of acidic type cleaning material rather than to an alkaline one. Such an acidic material will dissolve portions of those deposits that are untouched by the alkaline type of materials.

Deposits of water scale found on the tube interiors can also be removed with a specialized acidic type cleaning material. This solves one of the most complicated problems in heat exchanger maintenance work: Getting the scale off the tube surfaces without dismantling the equipment and without damaging the metal. In many instances where equipment is dismantled and hand methods applied to take off the scale, the cost is very high, and the results poor. Using rodding or drilling tools under air pressure, those methods cause a thin film of scale to be ironed out onto the surfaces that actu-

FIG. 1. Suggested form for recording case histories of the cleaning and descaling of each bundle. Such a cleaning chart helps to simplify the work of preparing and using the chemical solutions because dates, times, temperatures, and the like are seen at a glance.

TUBE BUNDLES CLEANING CHART

BUNDLE NUMBER 106-1 FROM #1 PIPE STILL

DATE	OAKITE MATERIAL USED	TIME IN SOLUTION	TEMPERATURE	DESCRIPTION OF DEPOSIT	RESULTS
1/18/49	Oakite Composition No. 19	4 hrs.	200 F.	SHELL: hard oils	Excellent
5/12/49	Oakite Comp. No. 19	4 hrs.	210 F.	SHELL: wax & gummy oil	Good
7/30/49	Oakite Comp. No. 19	3 hrs.	210 F.	shell: hard oils	Good
1/5/50	Oakite Comp. No. 19	4 hrs.	200F	shell, carbonaceous	clean surfaces

TYPE OF SERVICE CRUDE H.E.

	TUBE SIDE	SHELL SIDE
LIQUID	STEAM	CRUDE
TEMPERATURE	400°F	350° Fahr.

REMARKS

F.7614 PTD. U.S.A. OAKITE PETROLEUM SERVICE DIVISION

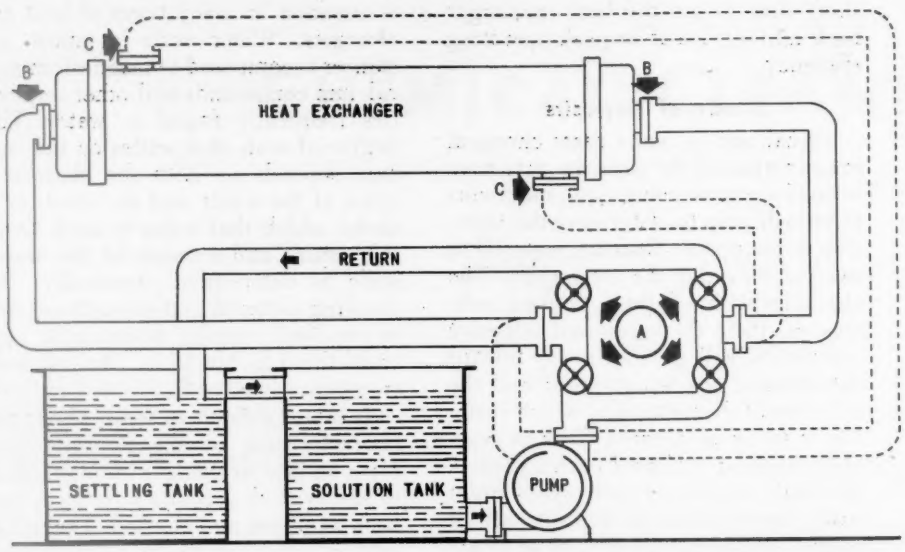

FIG. 2. Left, diagrammatic drawing of typical arrangement for cleaning heat exchanger tube bundles in place. By adjusting valves marked (A) the chemical cleaning or descaling solution is circulated either way through (B) the tube side, or through (C) the shell side, as indicated by broken lines. Provision is easily made for tie-in that cleans or descales a bank of exchangers.

ally serves as a permanent insulating film and prevents proper heat transfer even when the job is complete. The specialized acidic type cleaning compound developed for this work removes the water scale by dissolving it. Such an acidic material may be used to descale isolated heat exchangers by circulation or by tank immersion method. In general, the following are the main requirements of the cleaning and descaling materials that provide good results in heat exchanger cleaning work:

1. Should be safe for personnel to use.
2. Should be non-volatile and safe on equipment.
3. Should require a minimum of work for best results.
4. Should provide job-wide economy.
5. Should work quickly with minimum of equipment.

Cleaning the Heat Exchanger in Place

As pointed out earlier, one of the most efficient methods of cleaning and descaling heat exchangers (or a bank of exchangers) is to circulate the recommended chemical solution through the shell with the bundle in place. This *in place* cleaning and descaling has many advantages besides the effective, fast work it does. For example, it saves the extra crew that is usually needed for disassembling the heat exchanger and it saves the time they usually spend setting up rigging, pulling the bundles, and transporting them to the cleaning site. And, an important consideration, it frees maintenance men for other duties while the chemical solution is doing its circulation-cleaning work.

Cleaning and descaling heat exchanger bundles in place requires the following equipment: A solution tank.

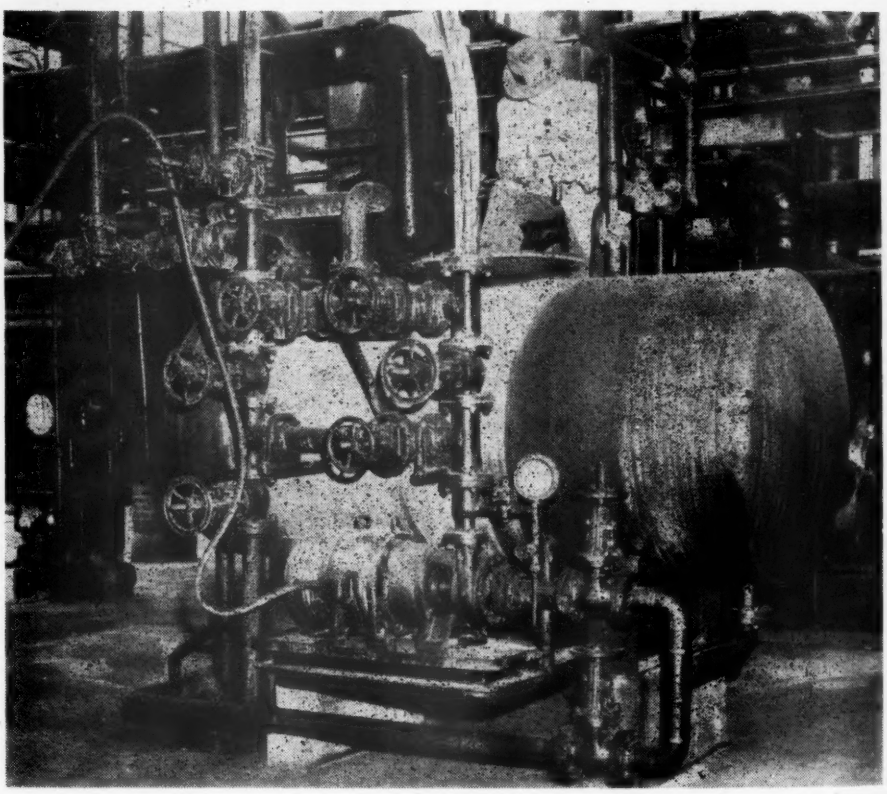

FIG. 2-A. Titrating the chemical solution at tank of permanent installation of equipment for cleaning and descaling heat exchanger bundles in place. Easily fabricated set-up permits refiner to clean and descale one of a bank of exchangers quickly.

settling tank, steam supply, pump, valves, and lines. This equipment may be installed permanently or temporarily at the site of the exchangers or mounted on wheels for transportation to its place of use. Best circulation of the cleaning and descaling solution may be obtained by using a duplex pump capable of delivering a solution equal in volume to that which the exchange equipment is designed to handle. This pump is connected to the oil side of the exchanger. It should be arranged so the cleaning solution can be flowed in either direction and eventually delivered to two containers of adequate size. This is shown in Fig. 2. Fig. 2A shows same set-up in permanent installation. Suction is taken on the solution tank, and the chemical cleaning or descaling solution is circulated through the exchanger. The solution should be heated for best results.

In starting the circulation method of cleaning or descaling, the system should first be reverse-flushed: that is.

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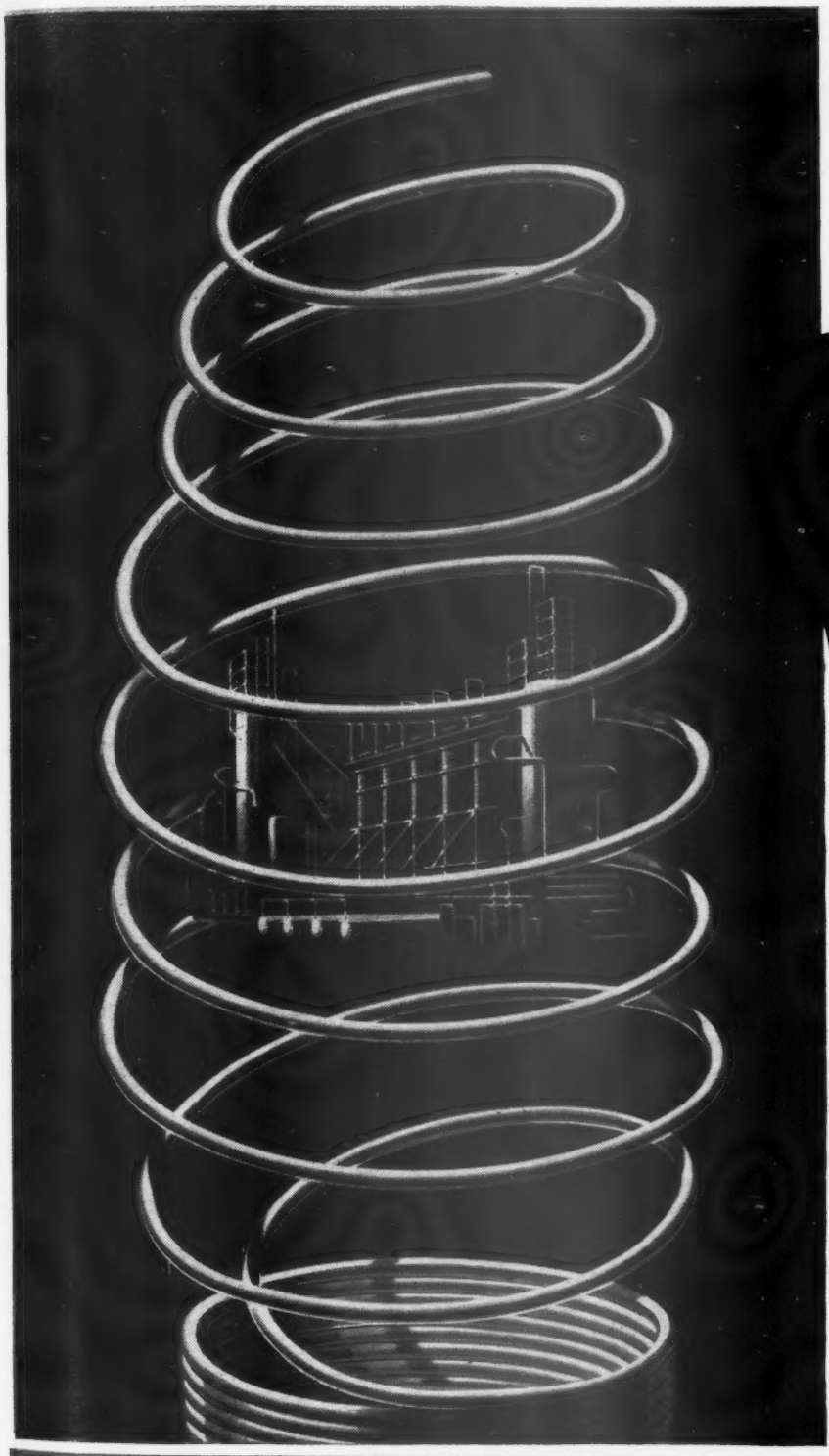

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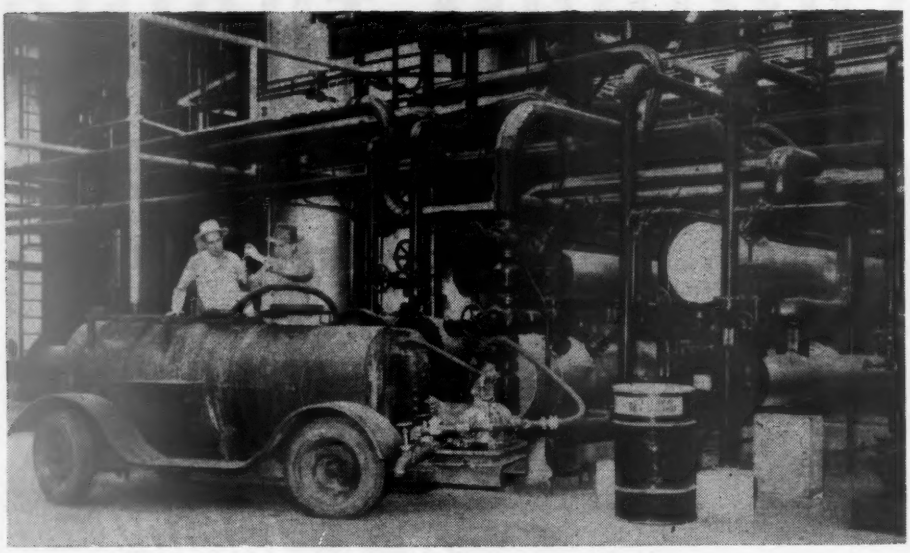


FIG. 3. Testing cleaning solution in tank of refinery-made mobile equipment, which can be rolled anywhere tube bundles are to be cleaned in place. Rearranging lines and adjusting valves make it possible to clean both tube and shell sides.

flushed against the regular direction of the flow of the product being processed. This quickly removes the heavy deposits that are usually built up at the inlet end of the exchanger, having settled out and formed there in the processing. Reverse flushing considerably shortens the time of the procedure by getting the bulk of the soils out fast, without spreading them over the other inner surfaces of the heat exchanger bundle. The illustration in Fig. No. 2 shows that this reverse flushing is done by closing the necessary valves to direct the flow in the desired direction.

After the cleaning or descaling operation gets under way, the introduction of intermittent air blasts into the solution in the shell side of the exchanger greatly helps in removing partially loosened soils. At the end of the circulation of the cleaning or descaling solution, the exchanger surfaces should be thoroughly rinsed by water under high pressure. Where an acidic type solution has been used to remove water scale, neutralization with an alkaline material should follow to make sure the action of the acidic material has been ended. Thorough rinsing follows this neutralization procedure to complete the descaling operation.

Titrating for Economy's Sake

A program of frequent titration should be set up once the cleaning or descaling operation is under way. This testing can be a big time saver because it indicates when the next step in the cleaning or descaling operation should be performed. For example, when an acidic material is being used, regular titration shows clearly when the cleaning or descaling work is finished. When an alkaline material is being circulated, regular titration warns if oil emulsifying properties of the cleaning materials have reached a point where the solution must be strengthened for continued effective, fast cleaning. Titration, then, can be seen as the simplest method of speeding up the operation; for, when the cleaning or descaling solution is held at the proper strength, soil-removing action is constant.

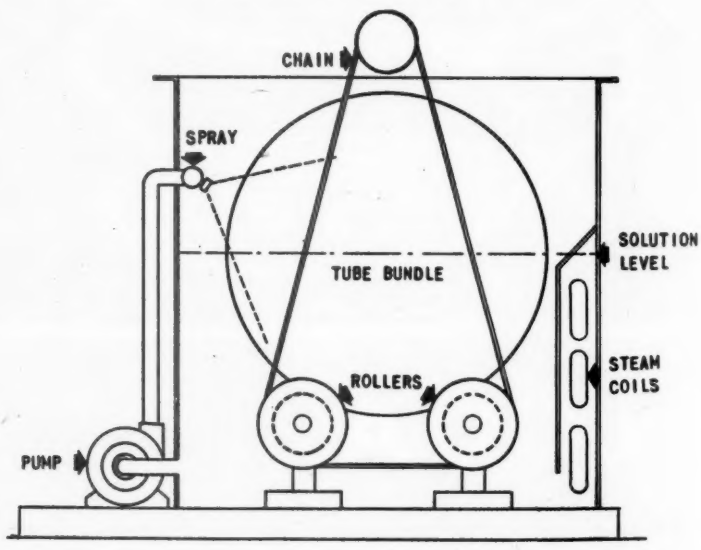
Mobile Equipment

Fig. 3 shows mobile equipment that may be used to clean and descale heat exchanger tube bundles at their point of installation without removal from the shell. Fundamentally, the unit consists of a large, partitioned tank mounted on a trailer; a pump and the same arrangement of valves for the installation recommended above, to permit a reversal of the flow of the cleaning or descaling solution and rinse water.

The size of the tank that can be efficiently used is determined by both the frequency of cleaning or descaling and the number of units to be cleaned. The tank, partitioned into 2 compartments, holds the chemical solution in one compartment and hot water rinse in the other. In some instances a second type of cleaning solution is carried in the second compartment to assure effective removal of different deposits that may be encountered.

To operate this type unit, the tank is charged with the recommended chemical cleaning solution and heated to the required temperature. The solution is conveyed to the exchanger by suitable connections. After the proper valves are opened the pumps are started. Where heavy soils are to be removed, a reverse flush may be necessary and may be accomplished by

FIG. 4. Diagrammatic drawing giving end view of tank for rolling tube bundles in chemical cleaning solution. Note attachment that provides for spraying solution between tubes to facilitate cleaning.



opening and closing the necessary valves to effect the re-direction of the solution.

Pulled Tube Bundles

Naturally, the method of cleaning and descaling tube bundles in place has tremendous advantages compared to removing the heads and dismantling the heat exchanger by manual methods. It saves time, and reduces damage to the tubes caused by pulling and handling. But where it is part of the operational plan to pull the fouled tubes and replace them immediately from a supply pool of clean tube bundles to provide time for corrosion tests, the tank immersion method, also using a chemical cleaning solution, provides good results.

Equipment for tank immersion method can be fabricated in the refinery maintenance shop. Fig. 4 shows a typical heat exchanger cleaning tank set-up. The cleaning action in this tank immersion work is accomplished by causing the exchanger bundle to revolve slowly while half submerged in the cleaning solution. At the same time, a series of sprays may be affixed to direct a spray of the cleaning solution at the portion of the bundle that is above the solution level.

A list of typical equipment for this work follows: A tank of heavy gage sheet steel provided with a pump suction outlet and suitable drains and strainers. A steam coil fitted in the tank so it will lie flat against the side and provide heat without interfering with the exchanger as it revolves. A shaft, powered by the motor, runs the full length of the tank and turns the rollers by chain drive. The tube bundle resting on these rollers turns as they turn.

In operation, the cleaning tank is charged with the chemical soil-removing solution—enough to half submerge the bundle. The solution is then heated to the proper temperature. The pump and revolving mechanism are then begun. While the bundle is revolved in the solution, on the rollers, the pump draws the chemical cleaner from the tank and discharges it through the spray nozzles.

The kind of cleaning solution—alkaline, acidic, or solvent—needed for tank immersion work depends, of course, on the product being processed, frequency of cleaning, and the temperature at which the deposits have formed. For example, long neglected heat exchangers processing sour crudes may often have a soil content of carbon, sulphides, oxides, light grease, and oil. A bundle with these deposits may best be cleaned in a chemical cleaning compound of a solvent nature to remove the oils and greases. Then it should be immersed in an acidic type cleaning solution to dissolve the sulphide and oxide based deposits. After sufficient soaking and turning, the bundle should be removed and submitted to a high pressure rinse. If some deposits still cling to the bundle surfaces after this rinsing, they may be quickly removed by spraying on cleaning solution combined with steam. Steam-detergent guns that correctly mix the cleaner and the steam are available in many sizes and types. Usually the same gun used to soften up and remove the deposits may also be used for spray rinsing procedures that should follow.

If water scale must be removed from the surfaces of the bundle, it should be immersed in another type of acidic cleaning solution for an average of one to three hours. Neutralization and rinsing follow to complete this descaling operation. Fig. 5 illustrates typical results of effective descaling action. If the bundles cleaned by the tank immersion method are to be stored until needed to replace other fouled exchanger bundles, they can be protected against rust. Another tank, placed near the cleaning solution container, filled with a special protective oil solves the rusting problem easily. After the bundle is taken from the cleaning, neutralizing, and rinsing operation, it may be dipped in such a specially designed protective oil to displace all moisture and protect the surfaces against rust.

Need for Problem Analysis

An important link in the chain of heat exchanger cleaning work is the actual adaptation of the cleaning methods discussed in this article to the different conditions encountered in various refineries. Proper adaptation is the result of discovering and answering many of the problems before they become costly mistakes. Thus the advisory services of the representatives of some manufacturers of chemical cleaning materials have become of great value in solving the many problems of adaptation. This has been a constant activity for many years and has led to the development and perfection of the circulation cleaning procedures mentioned in this article. The services of these men have helped many a refinery executive cut operating costs and reduce the out-of-service time for equipment.

Effective cleaning methods have also been worked out for other phases of petroleum industry; using chemical materials to clean all kinds of towers without cutting in, for example. Cleaning, stripping, and re-conditioning petroleum drums are others. All kinds of salvage work where effective cleaning methods help to revive for re-use thousands of dollars worth of sound equipment, and cleaning and paint stripping oil storage tanks with specialized chemical cleaning compounds are also on the list, as is the highly important job of chemically cleaning tank car interiors. Each of these subjects will be discussed in future articles, pointing out all along, the economies that can be established by replacing time-wasting hand methods and mechanical methods with safe, fast-working chemical cleaning procedures. * * *

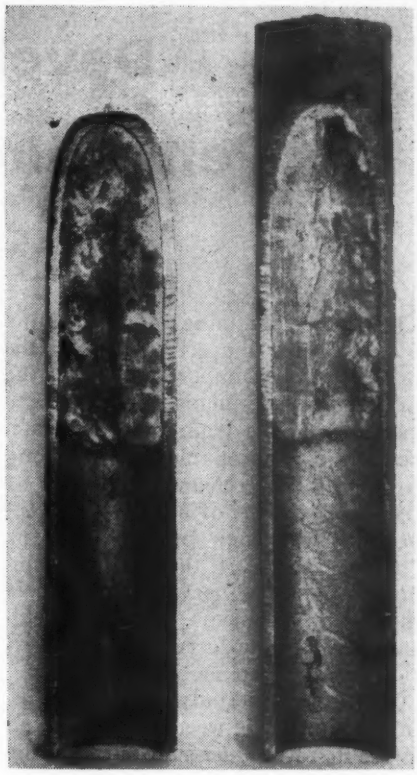


FIG. 5. Heat exchanger tube sawed lengthwise, showing how the water scale has been completely removed. Upper portion was untreated, illustrating the effect of superior descaling action.

Chemical Blotter

Oil, grease, kerosine, gasoline, and similar stains can be removed from the floor quickly with the aid of a new low-cost absorbent developed from petroleum. The compound is a grayish, granular material, and it acts as a chemical blotter. It can absorb and pick up spillings in excess of its own weight. Chemically inert, it is non-flammable—not even supporting combustion when saturated with oil, according to the manufacturers.

Development of Heaters for Petroleum and Chemical Processing

SCOTT E. NUTTER*

SINCE the beginning of the refining of petroleum, the art of heating the oil has been an important part of the process for producing the many and varied products from this raw material. As a general rule, each demand for a new petroleum derivative or the improvement of a standard product has posed new problems for the "heat-treating" of the oil. The improvement of refinery heaters to meet these new problems can be considered to have occurred in three periods of development.

In the first period of development, in the interval between the 1860's and 1900, there was demand only for the burning oils and lubricants. Gasoline and other lighter fractions outside of certain naphthas were discarded because of their volatile and explosive nature, having no saleable demand. During this era petroleum heaters were simple shell stills, consisting of a drum generally in a horizontal position over a fire box, into which crude would be charged in batches to be boiled-off or distilled down to cylinder stocks or heavier residues. The furnace was fired with residual oil from the still or, in some cases, was stoked with coal or wood in a fashion similar to that practiced by the steam generating industry.

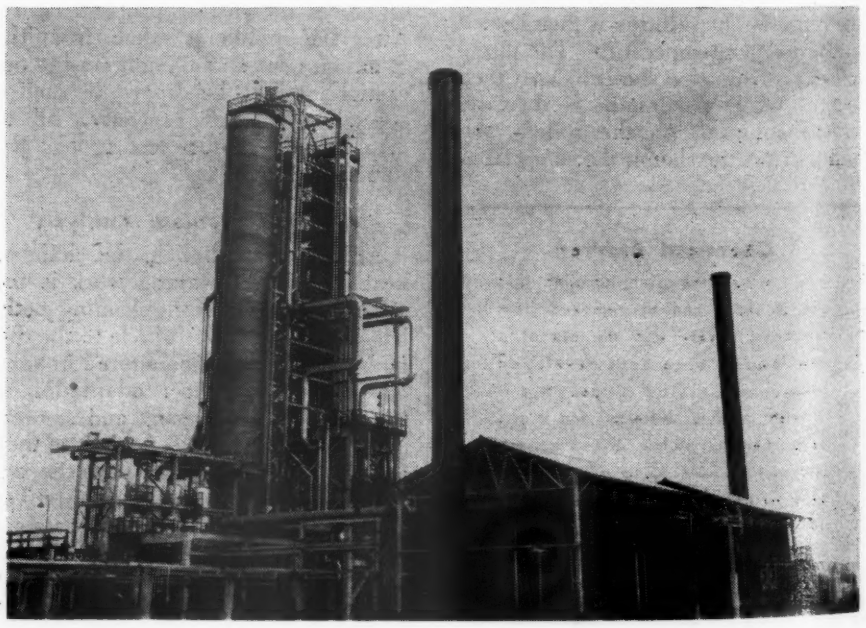
Near the latter part of the nineteenth century, with increasing demand for more petroleum products and with crude reserves apparently becoming exhausted, technical men concentrated on improving methods to heat-treat and recover greater quantities of products from crude. This surge of effort resulted in further developing the use of multiple shell stills, the application of steam to aid distillation, and experimental work with return tube systems in combination with shells, as well as other arrangements patterned after the steam-boiler industry.

The second era of development may be classified as the period between the years 1900 and 1925, and may be defined as an intermediate step in which, due to the advent of numerous inventions dependent upon petroleum products and due to the general accumulation of physical and chemical knowledge relative to hydrocarbons and structural materials used to build equipment to process petroleum, the stage was set for the highly technical advances to be made in the third and later developmental era.

The development of the refinery furnace or distillation unit in this period is clearly reflected in the United States patents for invention used during the time. From 1910 on there was a definite trend in patent application for the realization of more production of gasoline from the crude. This, of course, would be possible only by increasing the efficiency of heating and separating the crude or by means of the yet-to-be-developed art of cracking the heavy stocks into lighter fractions. (Cracking of heavy oils actually was discovered in the 1860's by accident, but then there was no practical use for the products). By 1905 and with each ensuing year, however, the cracking of petroleum became an urgent economic necessity as a means to produce more of the by-products of crude oil. As a result, by 1914 Dr. W. M. Burton had developed and operated one of the first successful commercial cracking units. These first cracking units employed batch operations similar to non-continuous crude distillation.

At the same time, the new petroleum reserves discovered on the Gulf and Pacific Coasts produced a much different crude than had heretofore been processed. These heavy oils yielded a low percentage of gasoline and they contained water. It was very difficult to obtain a separation of these type crudes in the shell-still because of priming and foaming, due to the water contained in the heavy oil. In order to control the vaporization of such an oil-water mixture, experimentation with heating these crudes in pipes eventually led to a commercial installation of a pipe still heater designed by M. J. Trumble on the Pacific Coast about 1911. The pipe still continued to be developed particularly for crude distillation from this period on throughout the time of the first World War. (The advent of this war, requiring for the first time in history the use of tremendous amounts of fuel, left little doubt in anyone's mind, thereafter, but that the control of petroleum reserves,

Crude distillation heaters, Lake Charles, Louisiana.



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with their complete and efficient utilization, would be the lever controlling world power.)

With new emphasis on demand for more and higher quality motor fuels for automobiles and airplanes, the refining industry turned seriously to developing the cracking of petroleum, and it followed logically that the tube-still should be developed as the primary method to heat and crack oil.

In these development days, little consideration was given to furnace design other than to furnish sufficient tube surface to get the required temperature. Cracking oil at the required elevated pressure and temperature for the ultimate yield of usable products and at the same time continuing on stream without injuring the equipment taxed the operating ingenuity of all plant men. Salt deposits, coke, burned tubes, all aggravated by poor furnace design and improper heat application, caused frequent furnace shut-downs. To overcome these difficulties, attempts were made in furnace design to entirely screen the tubes from direct radiant heat, and operate with large amounts of excess air. Reducing the combination of radiant and convection heat by eliminating direct radiant heat relieved the situation but caused low thermal efficiencies and failed to give a clear cut means to control the fluid temperatures. Most operators regarded direct radiant heat as something to be avoided. Increasing oil velocities within the tubes, thus improving the film transfer, was an important step during these development days.

Higher fluid temperatures required for cracking could not be attained unless the tubes themselves could be subjected to the effect of higher combustion temperatures. It followed then that to improve furnace design would require controlling the direct radiant heat. In 1924 A. E. Nash and J. S. Alcorn designed a furnace that accomplished this end by actually separating the radiant and convection heat application. They, in fact, provided substantially even distribution of radiant heat to the tubes or shell in a radiant heat zone, with separate provision for the reduction of the sensible heat of the combustion gases in a shielded convection zone. This important basic step opened the door for the rapid and successful development of modern heater design.

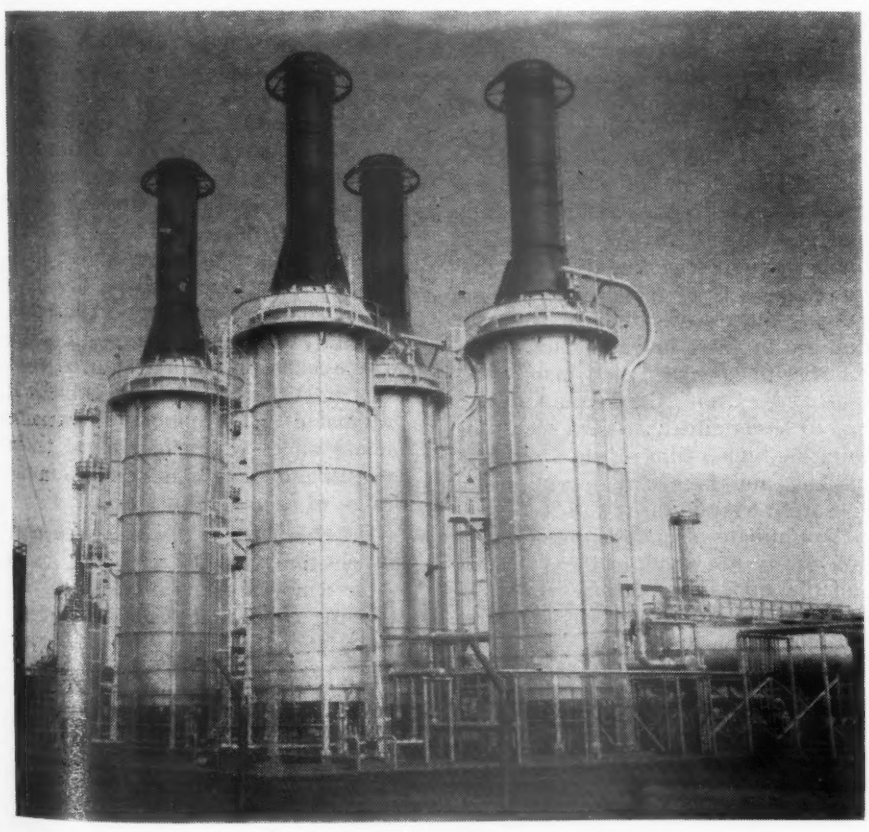
Entering the third period of development, beginning with 1925 up to the present year 1950, sufficient information was available from past experimental and practical efforts to establish a more scientific basis on which to predict results in processing and designing. Technologists were rapidly compiling data on the chemical and physical properties of crude oil and its derivatives and studies were made in pilot plants to determine the effects of time and temperature relative to the various cracking stocks. Also, a tremendous asset to aid further development of heaters and refining in general, which was revealed following World War I, was the introduction of ferro-alloy metals for the fabrication of tubes, pumps and structural members, resistant to the effects of high temperature and corrosion.

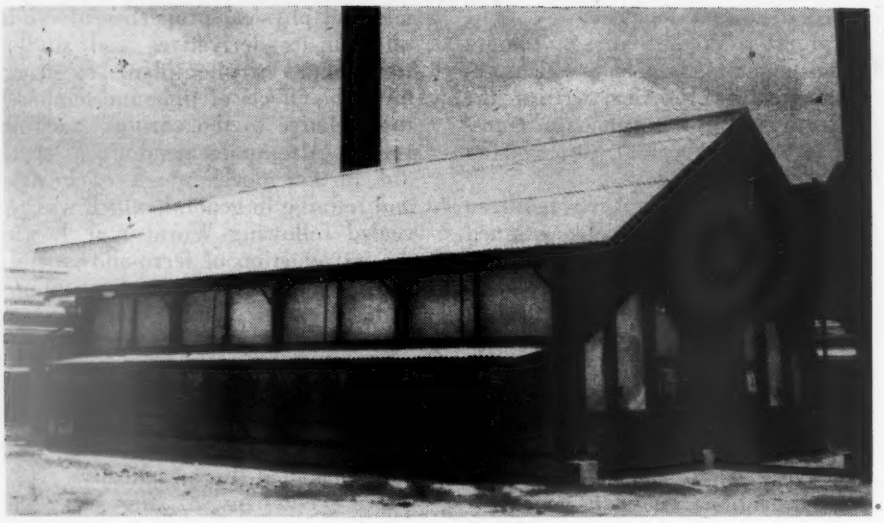
The variety of cracking processes increased rapidly, and from 1925 through 1930 cracking units had been installed by practically every refining company of any size. The first cracking runs were usually of short duration due to considerable difficulty with tubes in the furnaces coking and burning. This trouble was not entirely the fault of the furnace but in part could be attributed to other factors such as low mass velocities, dirty charge, and recycle stocks, as well as to the lack of flexible furnace design. Since the furnace was the heart of the entire oil cracking process, it follows that a majority of the cracking development centered around improving furnace design to handle effectively various charge stocks.

The early tubular cracking stills, regardless of charge stock to be processed, were generally box type structures with the radiant section tubes placed along one or more walls and on the roof, and with the convection section shielded with refractory walls. There was actually little control of the heat input to the oil within the tubes, except by changing the firing rate, thus affecting the entire furnace coil. To obtain the desired amount of cracking for a selected charge stock, reaction chambers or soaking drums were installed adjacent to the furnace to receive the heated oil and retain it for a predetermined time to complete the cracking reaction. In substance, these earlier cracking heaters served chiefly as a medium in which to heat the charge as rapidly as possible under pressure with a slight amount of cracking in the tubes.

Later, as development of cracking heaters progressed, banks of tubes were added for the expressed purpose or providing soaking time on the oil within the heater proper. This was a very important step in heater design, as this arrangement provided for a higher percentage of cracking in the furnace tubes and allowed more accurate control. Also, it was possible to reduce the size of the expensive reaction chambers and overall cracking plant maintenance was materially re-

Modern Petrochem heaters at Warren Petroleum Co. refinery, Maysville, Okla.





Direct-fired absorption oil heating units in side view —United Gas Pipe Line Company, Carthage, Texas.

duced. On the other hand, these heaters were not flexible to the extent of being able to process satisfactorily a variety of charge stocks each of which required different time-temperature relations.

Following the addition of soaking tubes in furnaces, the double end furnace was developed to give definite control and higher cracking yields in the tubes. This design, provided with two cells or radiant compartments, made it possible to heat the charge to a predetermined cracking temperature in one cell and then by separate and controlled heating, the charge could be retained at its cracking temperature throughout the soaking section comprised of the second cell. It was possible by using a sufficiently large soaking section in the heater, with controlled heat transfer rates, to entirely eliminate the reaction chambers.

The double end heater, with separately controlled heating and soaking sections, made a very flexible unit that could be adapted to the heating requirements of numerous charging stocks. Depending on the type oil to be cracked, the heating curve throughout a double end controlled heater could be varied between a straight line heating curve through the whole coil to one giving 100 per cent soaking time in the second compartment.

As the demand for premium high-octane gasoline grew, the intensity of cracking had to be increased to produce these distillates with higher anti-knock values. The controllable heaters, designed with separate heating and soaking sections, solved the problem of selecting optimum cracking temperatures for higher octanes with corresponding maximum yields. In addition to harder cracking of the heavy oils, refiners discovered that low octane straight run gasolines and naphthas could be upgraded in octane value by reforming. Reforming light volatile distillates with temperatures near 1100 F and pressures near 1000 lb presented new structural as well as new heating problems.

Structurally, carbon steel tubes and headers could not withstand the temperature and pressure conditions required for the new high octane production. Metallurgists solved this problem, however, by furnishing ferro-alloy tubes and headers with properties which eventually enabled them to withstand fluid temperatures in excess of 1500 F, such as used in some of our present day processes.

The higher fluid temperatures required to process cracking stocks added further complicating factors to furnace design. Reforming operations approached cracking in the vapor phase. There were actual vapor phase processes that required the heating and cracking of vapors and gases at temperatures exceeding 1200 F and at low pressure. In these processes requiring the transfer of heat from the flue gas to gases or vapors inside the tubes, with concurring low mass velocities of the fluid, the furnace design had to be modified to take care of the resulting higher film resistance to heat transfer and higher tube wall metal operating temperatures.

To elminate as much as possible any excessively hot spots in these heaters and the subsequent failure of expensive alloy tubes, it was necessary carefully to balance the heat absorbing surface relative to the heat reflecting surface. To do this, a greater proportion of reflecting wall surface was added in the form of more wall area or refractory firing wall surface. This increased the irradiation of all radiant section tubes and increased the fire box volume, which gave more even radiant heat absorption and reduced the chance of overheated tube areas from high concentrations of both the radiant and the convection heats.

Besides the physical arrangements of furnaces there were other factors that had to be overcome to allow high yields and long runs to make cracking in the coil successful. It had been demonstrated that the radiant heat should be evenly distributed and be kept separate from the convection heat to prevent burning certain tubes in the heater. It was found, also, that the condition of the charge oil and the rate at which it was forced through the furnace coils had important bearing on successful cracking results and the continuity of furnace operation.

With the earlier cracking furnaces, when the big proportion of cracking was done in a soaking drum or reaction chamber, the velocity of the charge stock in the tubes was accepted as a rule-of-thumb method in furnace coil design and was based specifically on cold velocities for the various types of cracking stocks. The fluid velocity was selected to assure turbulent flow in the liquid stage which generally assured a mass velocity in the mixed phase portion of the coil sufficient to maintain high film transfer rates and provided a washing action to aid in keeping the tube walls free of coke or sludge deposits.

As the amount of cracking in the coil was increased, with the addition of a soaking section for a maximum cracking yield in the furnace, the selection of soaking section tubes in size and quantity was based on the reaction time necessary to complete cracking of the charge above a given temperature. Since the percentage of cracking depended on the length of time a given mixture of oil was subjected to heat in the tubes above a certain minimum temperature, the tubes in the soaking coils were, therefore, selected for a given volume in which to retain the oil for its required reaction time. This soaking volume was predicated on a number of variable factors all of which had to be taken into simultaneous consideration in the design of each cracking heater.

The character of the feed influences the reaction velocity which increases as the temperature is increased. Temperature, time, and reaction rate are interrelated. Increasing the crack per pass gives less total gasoline yield but increases its octane rating, the formation of fixed gas, tar, and coke while the recycle oil ratio decreases. Therefore, designing the soaking coil is complicated by all these factors as well as

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the fact that the cracked products at the operating temperature and pressure conditions are usually above their critical temperature and will be in the vapor state. If this vaporization is neglected in the coil volume design then there will be insufficient soaking time and maximum gasoline yield cannot be obtained. To minimize coke depositing, due to dirty feed or recycle oil, the tubes are selected with minimum inside diameters to provide a high oil mass velocity.

Probably one of the most important developments assisting cracking operations, outside of actual furnace design, was the discovery of charging selected feed stocks and cleaning up the recycling material. Selective cracking, as it is called, limits the charge stocks for cracking to the individual fractions of crude, so that the cracking or heat-treatment conditions may be specifically set for a single type of oil. Before, when attempting to crack mixtures of various crude fractions, the easier-to-crack components would crack first and ultimately produce gas and coke before the more refractory components of the charge were cracked. Removing the heavy tarry ends from the recycle oil, with better fractionation, prevented these tars from being deposited on the tube walls as coke.

With the advantage of being able to use selective and clean furnace feeds it became possible to provide more exact furnace designs. Larger sized tubes with lower fluid velocities could be used in soaking sections and thus reduce the pumping cost. The higher recycle ratios were not required with selected feeds, and thus the furnace heating requirement was reduced as well as the required coil volume in the soaking tubes. The factor of time in furnace design was materially reduced. Instead heat input and temperature control became the most important cracking furnace design factor. If the cracking furnace is designed with two compartments, one in which to heat the charge and the other used to retain the charge at a cracking temperature, then it is possible with such a flexible furnace design to process a variety of charge stocks at varying cracking conditions.

Concurrently, as engine compression ratios increased requiring increasingly higher octane fuels, it became necessary to produce more engine lubricating oils of a quality sufficient to withstand the high bearing loads in the modern high speed engine. Solvent refining made it possible to produce quality lubricating oils from the more abundant low quality crudes. Characteristic of these solvents was the fact that they tended to break down or crack, thus losing their effectiveness when subjected to too high a temperature. Heating mixtures of these solvents and oils called for very close furnace design particularly as to the arrangement of the furnace setting to give even heat distribution and as to the selection of tube sizes.

In this type of furnace where high percentages of vaporization are required to saparate the materials with the aid of vacuum at the coil outlet, the mass velocity of the fluid in the tube is low, and consequently the film transfer rate is low. The mass velocity of the fluid in the tube acually controls the selection of the tube size, because, when translated into pressure drop, an increase in the mass velocity causes a corresponding increase in the "peak" temperature of the fluid. This peak temperature must be less than the maximum temperature that the solvent or oil can stand without deteriorating and it occurs from high "back-up" pressures in the coil by designing with too much pressure drop in the vaporizing tubes. Consequently, as the mass velocity of the fluid is held low to prevent high "back-up" pressures, the fluid film transfer is materially reduced as well as the washing action of the fluid inside the tube.

Since the fluid film resistance is great, due to the low flowing mass of fluid, the furnace must be arranged to assure absolutely even distribution of heat throughout the entire coil. It is preferred to arrange the coil in the furnace so that the path of the oil will flow counter current to the flow of the combustion gases. This gives assurance of maximum transfer of heat into the oil throughout all parts of the coil and minimizes the possibility of subjecting any part of the coil to high absorption rates that would cause incipient cracking of the fluid.

Other heating services requiring this same consideration in their design, not allied to solvent extraction, are ones for reducing lubricating stock, asphalt manufacture, and heaters used for the preparation of catalytic feed stocks. In all of these processes, the charge stock characteristically has a maximum peak temperature that cannot be exceeded when heated, because of the danger of cracking or vis-breaking that would cause deterioration of the oil. The reader will note that many furnace designers design heaters for these services with conservatively low input rates. This is to minimize possible bad arrangement in design and lessen the effect of higher heat input zones where the heat is a concentration of combined radiant and convection heats.

In recent years many new heating problems have resulted from the new processes developed for the manufacture of gasoline, chemicals, rubber and other products produced from petroleum, shale oil, the synthesis of gas or by hydrogenation of coal. Each new process requires "tailored" furnaces because the problems are so varied. Most of the synthesis work using petroleum fractions or natural gas for manufacturing rubber and chemicals requires furnaces giving high fluid temperatures, which, in some cases exceed 1700 F with working pressures at atmospheric and higher.

Furnaces used in hydrogenation work require quite different design consideration, particularly those used for the hydrogenation of coal. These heaters are required to heat slurry mixtures of powdered coal in oil in combination with hydrogen gas to pressures in excess of 10,000 psi and temperatures nearing 1000 F. This service presents a special design problem in that it requires subjecting tubes, at these pressures and temperatures, to heat that must be transferred evenly into a mixture comprised largely of solids.

The design factor that makes a furnace operate successfully and safely for any order of heating fluid in the tubes is the uniformity with which both the radiant and convection heats are applied, together with the control thereof. In furnace operations, even in those of low order heating, it is not advisable to group tubes into a furnace setting and in the design neglect furnishing a reasonable ratio of reflecting surface to tube surface.

The even application of heat to the tubes can only be accomplished by designing the furnace with a reasonably large proportion of reflecting wall surface to tube surface. The proper arrangement of each surface is necessary to cause each radiant tube to be irradiated with both direct radiation from the flame envelope and reflected radiation from the refractory walls. This arrangement gives high percentages of radiant heat extraction in the radiant section and as a result reduces the temperature of the combustion gases leaving the radiant section to a reasonably low degree. The radiant tubes are irradiated evenly making it possible to safely heat such fluids as vapors with low mass velocities at high temperatures, also this design makes it possible to heat solids, as in hydrogenation operations. Furnace fire box volumes consequently are greater thus giving lower volumetric heat intensities, which lends further assistance to giving uniform heat transmission without danger of flame or hot gas impingement. * * *

Repair and Maintenance of Cat Cracking Equipment

Staff of 34 Men Maintains a Small Unit At 92.5 Per Cent Operating Efficiency

WILLIAM F. DOUGHERTY

The Author

William F Dougherty was graduated from Penn State in 1942 with a BS in petroleum engineering. He served as engineering officer, combat battalion, from 1942 until 1946. In 1946 Dougherty became associated with Leonard Refineries, Inc. as chemical engineer and since that time has been working as combustion engineer, metal inspector, and the head of the refinery yield department.

THE thermofor catalytic cracking plant at Leonard Refineries, Inc. in Alma, Michigan, was put on stream in March 1947. This unit had a design capacity of 3500 bbl a day reactor charge. The operating capacity, however, was found to be approximately 5500 bbl a day. This unit is operated by a crew of three men, namely, an operator, a kiln man, and a control man.

The maintenance program is broken down into two groups, which are (A) normal maintenance. and (B) the maintenance required during a turnaround. In group A, are such items as pump maintenance, engine and compressor maintenance, instrument maintenance, exchangers, condensers, turbines, electrical maintenance, piping, painting, insulating, sewers, steam system, cleaning pumps and building, emergency repairs, valve maintenance, catalyst loading and fines removal. Most of these maintenance items mentioned are very similar to any other equipment used in the refinery and are treated in the same fashion.

The normal maintenance program may be broken down in the following manner for an average month's operation:

1. Material cost/month	$ 650
2. Manhours/month	700
3. Cost of manhours/month	900
4. Total cost/month	$1550

There have been three turnarounds on the unit since it went on stream. Two shutdowns per year were anticipated but after the first two, the unit was put on a yearly basis. At this writing the next one is set for the latter part of April and the first part of May, 1950.

A turnaround in a modern small refinery is no haphazard, hit or miss affair. It must be a well planned and coordinated operation. It must include the keeping of detailed records of each piece of equipment and its condition at periodic inspections.

At least four weeks before the proposed shutdown, a meeting is held to determine what work is to be accomplished and in what order it is to be carried out. All the foremen and operating personnel who are not on shift are present at this meeting. On the TCC unit, two maintenance books are kept, one for normal and the other for shutdown work. The shutdown repair book is gone over very carefully and all items are decided upon. The last written shutdown list is reviewed and any necessary checking is taken care of. The previous written inspection report is discussed point by point. Also, at this time, any material that is needed for the shutdown is checked to see if it is on hand or if the delivery date can be confirmed. The date and time of the shutdown is set and an estimate of its length is made.

As soon as possible after the first meeting, a complete shutdown work list is prepared and copies sent to all the foremen. This list divides the work to be done into the proper departments.

One week before the shutdown, another meeting is held where the maintenance foreman outlines the work schedule. He will give an estimate of the manhour breakdown of the various jobs and the procedure to follow in order that all work will end at approximately the same time. This estimate is only a guide and may be constantly changed once the shutdown begins.

Our regular maintenance force is made up of 34 men and they are listed as follows:

1—Maintenance superintendent
1—Machinist foreman
1—Pipefitter and labor foreman
1—Painting and insulating foreman
1—Electrical foreman
1—Instrument engineer
1—Pipefitter first-class sub-foreman
1—Storeroom manager
1—First-class welder

EXCLUSIVE

1—First-class carpenter
1—First-class painter and insulator
1—First-class machinist
1—Second-class machinist
1—Second-class pump mechanic
1—Second-class painter and insulator
3—Second-class pipefitters
6—Pipefitter helpers
1—Painting and insulator helper
1—Carpenter helper
3—Yardmen first-class
2—Yardmen second-class
3—Process extra board

It is necessary to hire about ten extra men during a turnaround. All the maintenance personnel are divided into two shifts. Each shift will work 12 hr for a 6-day week. The operating men remain on their regular 8-hr shifts but act as supervising foremen on particular sections of the unit.

The mechanical department is made up of 4 men who spend their entire time on engines, compressors, pumps, and turbines. As a rule, they have two extra men to help them during a turnaround.

The insulators take off and replace all insulation after the necessary inspecting and repairing has been completed. They also do all the painting on the stacks. This crew takes care of the repair work on the boilers.

It was found that more work is accomplished by working a 6-day week and giving one day of rest, as a faster and better job is done. The men are all better pleased with this arrangement rather than working straight through until the unit is back on stream again.

The Houdry Process Corporation supplies two engineers and a qualified metal inspector for each shutdown. The engineers go throughout the entire unit making visual inspections. They

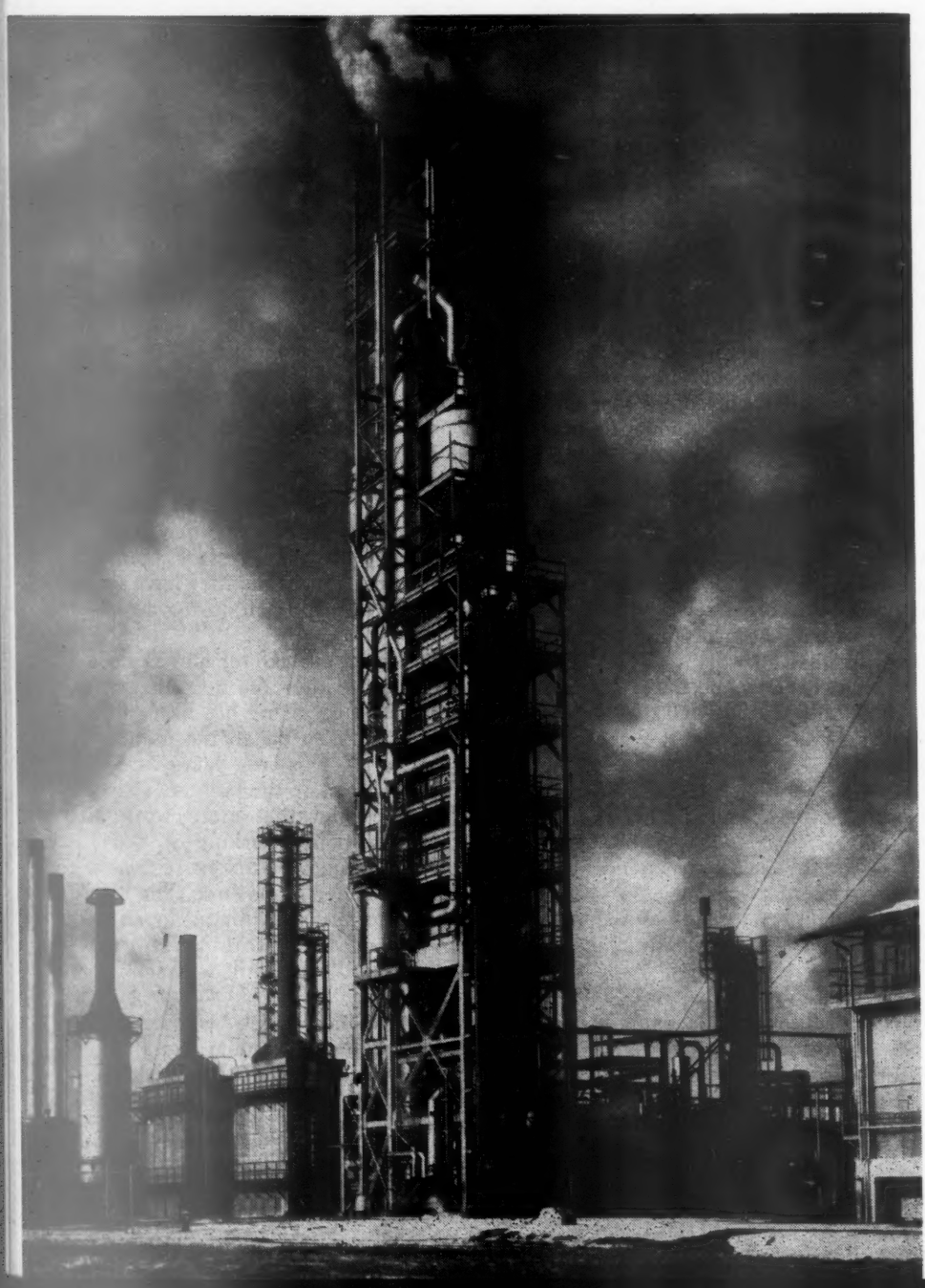
compare their results with the last written inspection report. The metal inspector supervises the inspection work and along with our own inspector, makes all the measurements. They make external and internal inspections of all equipment wherever possible. They also do the required amount of hammer testing, drilling and calipering through the open ends of the pipes, tubes, and manways. The metal inspector from Houdry keeps a set of the data taken and in approximately two months after the shutdown, several copies of a very detailed report are returned to the refinery. He also recommends any additional repair work that may have turned up from the inspection. This work is fitted into the schedule by the maintenance foreman.

1st Turnaround—	*Hours*	%
Total hours on stream (9:30 pm, 3-18-47 to 12:40 am, 10-27-47)	5140.2	
Total hours (9:30 pm 3-18-47 to 12:40 am, 10-27-47)	5331.2	
On stream efficiency		96.4
2nd Turnaround—		
Total hours on stream (12:40 am, 11-7-47 to 12:01 am, 4-19-48)	3919.3	
Total hours (12:40 am, 11-7-47 to 12:01 am, 4-19-48)	3935.3	
On stream efficiency		99.6
3rd Turnaround—		
Total hours on stream (12:50 am, 5-1-48 to 12:01 am, 4-18-49)	8193.0	
Total hours (12:50 am, 5-1-48 to 12:01 am, 4-18-49)	8447.0	
On stream efficiency		96.7

Recapitulation of stream efficiencies over entire life of unit including most recent turnaround and inspection.

9:30 pm, 3-18-47 to 10:15 pm, 5-3-49	
Hours off-stream during first run	191.0
Hours required for first turnaround	264.0
Hours off-stream during second run	16.2
Hours required for second turnaround	288.8
Hours off-stream during third run	254.4
Hours required for third turnaround	382.3
Total hours off-stream (9:30 pm, 3-18-47 to 10:15 pm, 5-3-49)	1,396.7
Total hours elapsed (9:30 pm, 3-18-47 to 10:15 pm, 5-3-49)	18,601.7
Overall stream efficiency during life of plant	92.5

Leonard refinery at Alma, Michigan.



Reactor

During the past three turnarounds, heavy coke deposits were encountered in the reactor. The walls, catalyst downpipes, and other internal members above the catalyst level were completely covered with coke. Heavy stalactites of coke were found hanging from the underside of the seal chamber, liquid feed slide valve assembly, and nozzle assembly. Some of the coke was as much as 5 in. thick, 2 to 3 ft in length. The coke deposits were heaviest on the portions of the assembly closest to the point of the reactor vapor line. During the last turnaround, it was estimated that 8 tons of coke were removed from this section.

Kiln

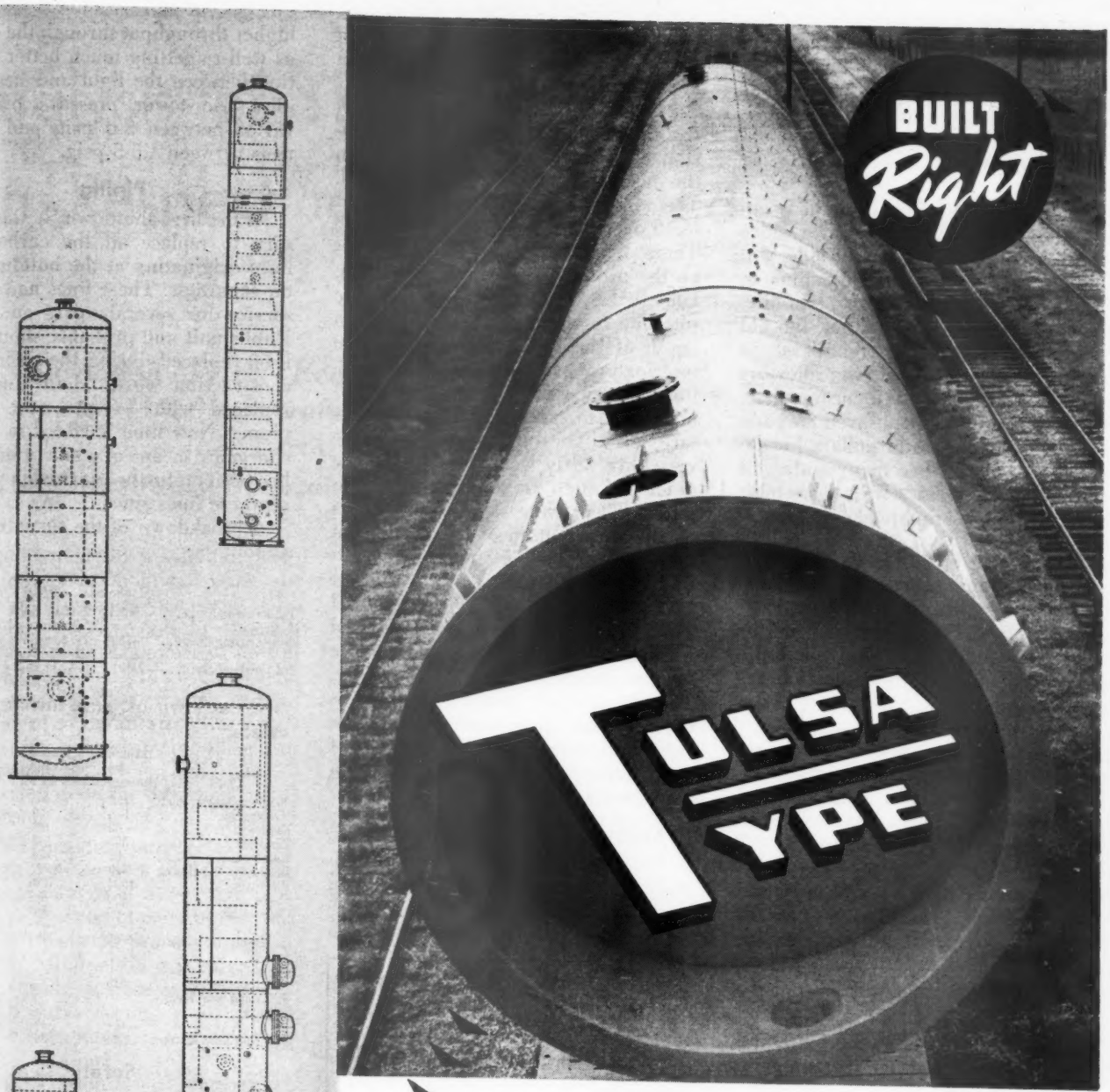
The kiln has always been in good condition at each inspection and only minor repairs have been noted.

Catalyst Chopper Valves

The catalyst chopper valves in the side compartments were worn sufficiently on the shut-off edge to warrant their reversal. After 2 years of operation, the stellited wearing edges were worn from an original ½ in. by 19/64 in., the worn area extending for about 2 in. from the edge in the center of the gate and tapering to zero on the sides. The center chopper gate (spent catalyst) was worn only slightly and did not warrant reversing.

Hot Catalyst Elevator

Under guidance of an engineer from the Jeffrey Manufacturing Company, a complete reconditioning of the elevator was accomplished at the last



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turnaround. This included the installation of a new chain, new head shaft, bearings and seals, one foot shaft wheel, and new guide shoes on one side of the elevator at the top. The old foot shaft wheel was found to be cracked.

The life of an elevator chain is approximately two years. However, since it has been worn only on one side, you may rebush it and turn the pins to give you an additional two years' life. Our salvage department took the old chain and completely rebuilt it in about seven months without allowing their normal salvage to accumulate. The salvage department saved the company several thousand dollars by doing this work rather than sending it to another company which has rebuilt several chains for major companies.

Primary Gas and Water Separator

The gas and water separator is a barometric-type, direct contact condenser. The overhead vapors from the synthetic crude tower are cooled and partially condensed, and the rich gas and unstabilized gasoline are withdrawn from the vessel.

During the first shutdown, this gas and water separator was visually inspected and found to have suffered excessive corrosion of the unit cell type. Some pits were measured 3/32 in. deep. The corrosion was greatest in the portion of the vessel near and below the liquid line. The vessel walls and ends were sandblasted in this area and covered with a plastic paint specially recommended for protection against sulfur-laden material.

The vessel was inspected again during the second shutdown and corrosion existed along the walls between the dams and below the gasoline level. The corrosion was irregular and scattered over the lower half of the vessel. There were numerous small blisters on the protective coating of the tank. Under the blisters were measurable pits due to corrosion. The maximum depth of these pits was 0.07 in. The interior protective coating is not holding up very well on a band approximately 12 in. wide at the water interface level. The other sections of the vessel are fairly well protected by the paint although these areas are also pitted. There were several bare spots on the very bottom of the vessel, but there was no visible corrosion or pitting in these areas.

At the third shutdown, the vessel was again sandblasted and painted with the same plastic material as the former coating had deteriorated badly. The deepest pit marks found measured 0.11 in. with areas of corrosion extending over the entire surface of no definite pattern, the lower section being somewhat more severe.

Synthetic Crude Fractionator

The bottom 7 trays of the fractionating column were replaced during the last shutdown with new Koch Kaskade decks. The new trays allow a higher throughput through the column as well as getting much better separation between the light and heavy gas oils. The tower pressure originally varied between 3-6 psig and now it runs between 1.5-3 psig.

Piping

At the first shutdown, it was necessary to replace all the carbon steel lines originating at the bottom of the tar separator. These lines had been in service for several years on the old Dubbs unit and probably should have been replaced during the tie-in of the construction work. These lines were replaced with 4-6 per cent chrome piping. Now lime is added to the raw charge by means of a slurry and there has been no further corrosion problem on these lines since.

A breakdown of the turnarounds is as follows:

	Manhours	Shifts	Length of shutdown
1st turnaround.....	5053	2-12-hr shifts (continuous)	264
2nd turnaround.....	3362	2-12-hr shifts (continuous)	289
3rd turnaround.....	9591	2-12-hr shifts (6-day week)	382

Breakdown of each turnaround by crafts:

Craft	Manhours 1st turnaround	Manhours 2nd turnaround	Manhours 3rd turnaround
Operating supervision	792	864	1838
Mechanical.....	1?1	963	1260
Electrical.....	62	148	240
Welding.....	375	173	592
Instrument.....	62	126	223
Insulating & painting	349	227	1200
Pipefitting.....	1622	280	1000
Carpentry.....	500	288	384
General labor.....	1160	293	2854
Total.....	5053	3362	9591
Replacing old tar lines & transfer lines....	845	....	....
Installing new Koch trays.....	....	....	1038
Net shutdown manhrs	4208	3362	8553

Safety

One of the main points stressed during the turnarounds is the safety of the men who are working on the unit. All men are required to wear protective helmets at all times. We have been very fortunate in having only one very minor accident on turnarounds on the TCC unit.

The maintenance department has completed 12 months without a lost-time accident, and a period of 8 years without an accident that could be considered other than a minor one. There has never been a fatal accident in either the maintenance or operating departments since the plant started in 1936.

Ever since the TCC unit was first contemplated, the idea of handling maintenance problems during turnarounds with a small force seemed difficult. Now the staff is very confident that it will be able to take care of any maintenance work in future turnarounds with the company's own small maintenance force. * * *

A "Pumpless" Air Compressor

This sketch shows how any refinery mechanic can convert water pressure into compressed air without the use of a pump or any other equipment except a "pressure container" of some kind.

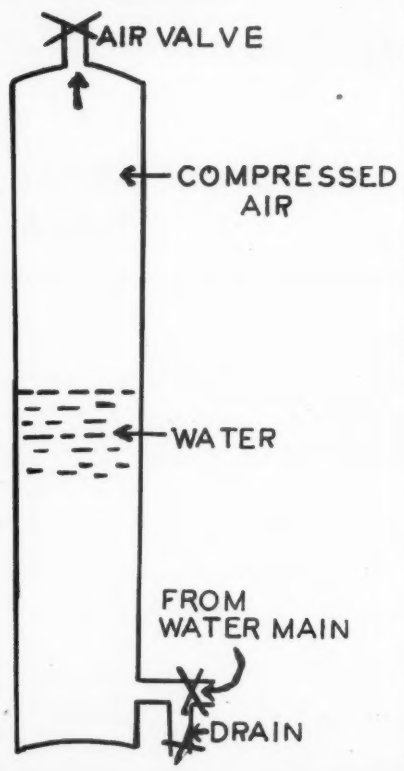
Often there is an emergency need for compressed air. In most cases, by exercising a little ingenuity compressed air is obtainable.

The sketch shows how an ordinary water tank can be utilized. The method of operation is simple, as follows:

Close the "air valve" at the top and allow water to enter at the bottom. When the trapped air attains the same pressure as water in city water main, inflow of water will cease.

The compressed air can then be used for any purpose such as paint spraying, filling automobile tires, bicycle tires, dusting, blowing scale or dirt out of pipes or radiators, spraying plants or anything else, starting diesel engines, etc.

As soon as the tank is full of water, drain the water out and repeat the process.—W. F. S.



Analysis of Thermal Insulation Problems In Respect to Refrigerated Equipment

JOHN F. STONE*

Calculation of Exact Requirements for Insulation for Low Temperatures Is Based on Carefully Determined Factors and Experimentally or Industrially Determined Values.

To some extent all insulation problems hinge on economic factors, but in refrigeration practice especially, operational requirements are considered first and the economics of several possible materials or of varying thicknesses considered afterwards. Fortunately, most of the information that is required has a bearing on both sets of considerations.

Information on the following points is required:

(a) The primary purpose of insulation in respect to each major constituent of the system.
   1. Most economical operation?
   2. Accurate process control?
   3. Elimination of hazard resulting from excessive pressures?
   4. Economy in use of refrigeration?
   5. Prevention of damage resulting from condensation and frosting with attendant increase of corrosion?

(b) Conditions of operation.
   1. Insulated equipment outdoors or in buildings?
   2. Temperature conditions steady or cyclic?
   3. If there is considerable temperature change, is it rapid?
   4. Are there special conditions to be considered such as considerable vibration or an unusual degree of fire hazard?
   5. Are any of the substances to be handled known to be deleterious to insulations commonly used in the specific temperature range?
   6. What number of hours operation per year is expected?
   7. What is the estimated cost of refrigeration or heat?

(c) The anticipated useful life of the plant or process under consideration.

This question is basic to any rational estimate of the economics of insulation. It is obvious that a proved process known to permit profitable operation should be designed and constructed to give the maximum overall return; while in the case of a pilot plant that is to prove a method or design, no first cost is warranted beyond what will permit successful operation.

Most refinery and chemical process equipment has considerably less thickness of insulation than do cold storage warehouses, food freezers, and similar installations for equal temperature differences. This is due not to different schools of thought among the designers nearly as much as it is to the longer amortization periods set up for heavy permanent buildings used in a type of business that is not subject to as wide fluctuations as the industrial process industries. In addition, large industrial plants usually enjoy lower refrigeration costs than do warehouses and food processors, partly because of lower fuel or power costs.

In *The Petroleum Engineer* for January, 1950, page C-11, there is a table of thicknesses that represents common practice in industrial plant designing. A comparison of these thicknesses with the standard recommendations for cold rooms of any experienced insulation manufacturer reveals large, almost startling, differences. For example, the usual thickness for a room held at 0 F to —20 F is 8 in. The table mentioned shows 5 in. The reason is almost entirely economics. It should be noted here that room and building insulation is nearly always cheaper for a given thickness than insulation on tanks, vessels, etc., and no similar discrepancy is found where pipe insulation recommendations are concerned.

In theory the economics of thermal insulation present no real difficulties. In the nineteen-twenties, two rational analyses were published, one by Nichols,[1] the other by McMillan.[2] Although the formulations were not identical, both said essentially the same thing, viz., as the thickness of insulation increases, its cost goes up but the cost of refrigeration (or heat) goes down, therefore the point at which the sum of these two costs is a minimum is the most economical thickness. An adaptation of McMillan's equation to refrigeration units can be found in *Refrigerating Engineering*,[3] for July, 1943, p. 31 (46, 1, 31; published by the American Society of Refrigerating Engineers). For derivation of the McMillan equation, see also Appendix A, to this article.

Calculations according to the McMillan formula are valuable not as exact determinations but as convenient first approximations. The basic difficulty is that insulation costs do not progress in a smooth curve. McMillan's equation assumes:

(1) There is a definite cost regardless of thickness that covers such things as scaffolding, transportation, supervision, overhead, finishing.

(2) After allowing for (1), the cost is approximately linear with thickness.

Unfortunately (2) is true only to a limited degree, for the actual cost progression is a series of steps, each sharp increase indicating another layer of material and the slopes between representing increasing thickness without the number of labor operations changing. This is illustrated in Figs. 1 and 2.

The McMillan formula, modified to apply to insulated equipment where there is no significant thermal resistance aside from the insulation and the small surface resistance, is shown later and it is apparent that the practical difficulty is choosing a value for b, the cost per year per square foot of insulation per inch of thickness. No

*Insulation Engineer, Johns-Manville.

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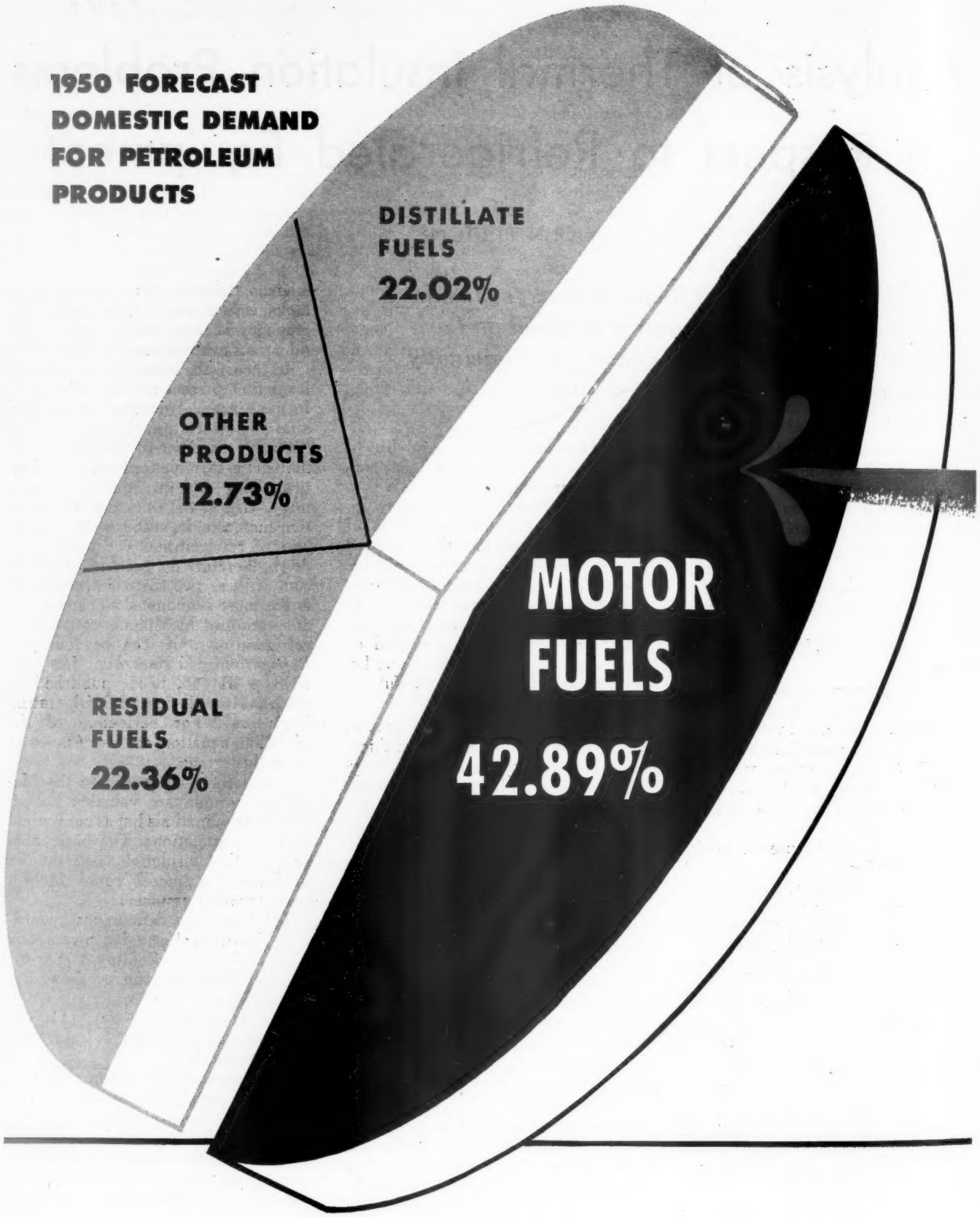
1950 FORECAST
DOMESTIC DEMAND
FOR PETROLEUM
PRODUCTS
DISTILLATE
FUELS
22.02%
OTHER
PRODUCTS
12.73%
RESIDUAL
FUELS
22.36%
MOTOR
FUELS
42.89%

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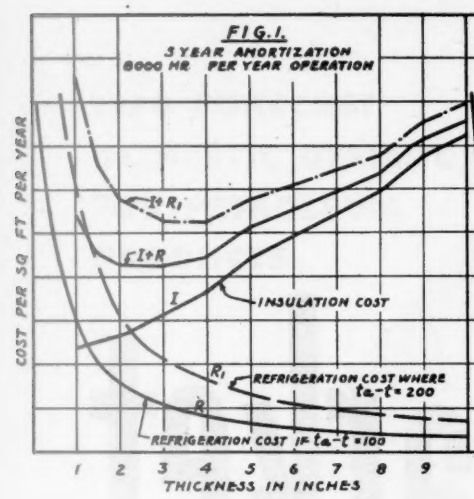


FIG. 1

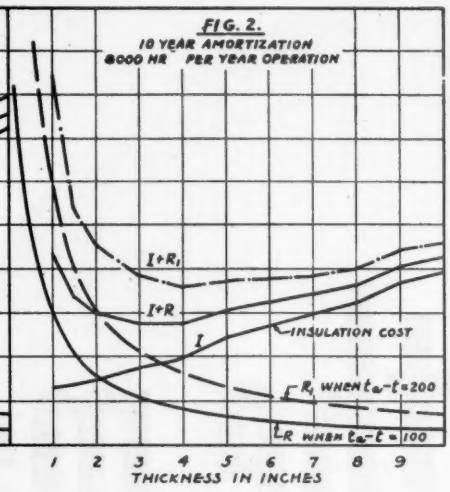


FIG. 2

generalized answer, applicable to a wide variety of conditions, is possible. Figs. 1 and 2 were constructed by assuming a set of costs per square foot for insulation. The conditions were chosen arbitrarily and represent no specific case. Figs. 3 and 4 were based on determining the difference in cost between 1 and 9 in. thicknesses and dividing by eight to get the uniform increment demanded by the McMillan equation.

It is apparent that, proceeding in this fashion, a close approximation is secured to the results of tabulating and charting the costs. In Fig. 1, it appears there is no economic choice on the $t_a - t = 100$ basis between 2 and 3 in., so the latter would be chosen to gain the benefit of lower refrigeration usage at moments of peak load. Where $t_a - t = 200$, the lowest combined cost is at 3 in. As shown in Fig. 3, the McMillan equation gives values of 2.2 in. and 3.2 in. An equally good correlation is noted between Fig. 2 and 4, where the plot of the costs shows for $t_a - t = 100$ that economically 3 or 4 in. are about equal and for $t_a - t = 200$ that 4 in. is slightly better than 5 in. The McMillan results are 3.2 and 4.6 in.

One thing that stands out is that on refrigerated equipment the theoretical economic thickness is rarely usable. Operating conditions and requirements generally require greater thicknesses. This does not follow for heated equipment that has no problem of frosting or freezing and rarely any concern over condensation.

Several suggestions have been advanced for other methods of determining proper thickness of insulation, but none has been accompanied by any closely reasoned exposition of its validity.

Surface temperature has been suggested as the criterion. This is fallacious in its major premise, except for one special and rare condition, that the insulation is used only to prevent injury to plant personnel. The designer is not directly interested in surface temperature, and it has no constant relation to the rate of heat transfer. Another more persuasive idea is that the last increment of thickness shall yield a specified return on the investment.

The simpler and more logical argument is that the desired result is the lowest overall cost to the owner. Regardless of the method of calculation, the maximum return will be realized only by consideration of both operating cost and investment. The minimum value for either may not give the most economical result.

A different approach has been suggested that takes note of the fact that certain costs are present regardless of the thickness of insulation and that these must be treated separately—for example, the cost of a first-class, durable and practically maintenance-free, outer finish or casing. This has a value of its own and should be balanced against greater upkeep of a cheaper finish plus consideration of the possibility of failure of the cheap finish with serious impairment of the whole investment.

This consideration, though perfectly valid, does not impair the usability of the McMillan equation, which, as pointed out, includes a constant to provide for this point. Regardless of the size of the constant, the economic thickness comes out the same as the only variable in "I", the insulation cost (Fig. 3 and 4), is the cost of the insulation itself.

In addition to the information already listed, it is necessary to know the following to check on operational requirements:

1. Designed temperatures of all items.
2. Allowable limits of heat loss or entry, if any.
3. Average, maximum and minimum air temperatures to be expected, and associated relative humidities.
4. Where end temperature is a factor, the rate of flow, characteristics of the fluid such as specific heat, specific gravity, and sometimes viscosity.

The tools used for insulation analysis are quite simple. A table of the significant properties of insulations can be compiled from manufacturers' literature, amplified by data in the handbooks such as the *Refrigerating Data Book* (A.S.R.E.) and the *Guide of the A.S.H.&V.E.* Most of this information including that which pertains to heated equipment can be found in Sweet's Engineering File and Sweet's Process Industries File. In the January, 1950 issue of *The Petroleum Engineer*, page C-12, there is a table

FIG. 3

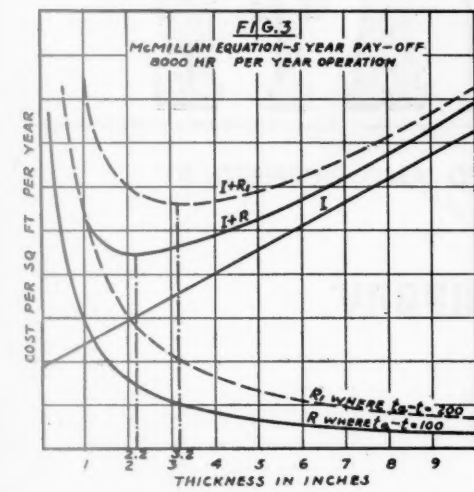
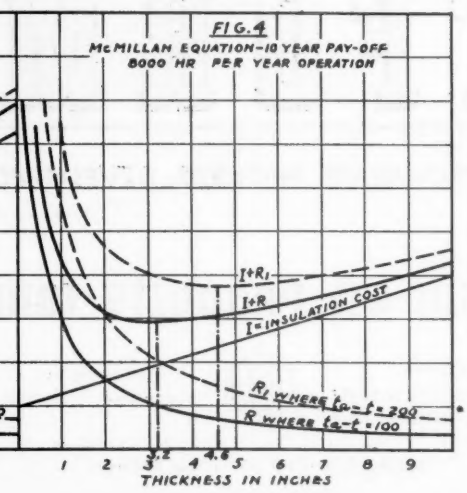


FIG. 4



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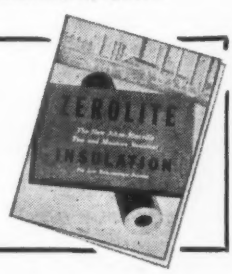

Johns-Manville ZEROLITE

REFRIGERATION INSULATION

of properties of commonly used refrigeration insulation. Any of these tables must be used with understanding. Commercial insulants are not precision materials and numerical values assigned to their characteristics are either averages of many observations or test results on samples assumed to be fairly representative. This explains why different observers report values sometimes appreciably at variance with each other.

With the table of properties of the materials at hand, the other tools consist of psychrometric charts or tables, a good handbook incorporating steam and refrigerant tables, natural logarithms, and common conversion factors, preferably a relatively simple form of calculating machine although if this is not available a 10-inch slide rule will give results within the accuracy of the data usually available.

For convenience, the author has made for himself a notebook containing the items noted and gradually built up additional tables such as ratios of outer and inner radii of insulation, values of natural logarithms of these ratios and "equivalent thicknesses" all of which are useful time savers when figuring insulation on curved surfaces, such as pipe and small vessels. On another sheet appear the commonly used equations for heat transfer through insulation. These equations, which follow, rest on a few basic assumptions:

1. Heat flow is directly proportional to temperature difference and inversely proportional to the insulation value or thermal resistance between the two temperature levels.
2. The thermal resistance of any substance is directly proportional to its thickness and inversely proportional to its conductivity.
3. Conductivity as used herein is a specific property of a material, determined by experiment, which varies with temperature but not with shape. It is expressed in Btu per hour per square foot per degree F temperature difference, through one inch thickness of the material.
4. Surface resistance is the reciprocal of the rate of heat transfer between the surface of a material and the adjacent air. It varies inversely with the rate of heat transfer and the velocity of the air over the surface, and has been established by experiment with fair accuracy.

Definitions of symbols.

k = conductivity (defined above)

R = thermal resistance (defined above)

R_s = surface resistance (defined above)

x = thickness of a material in inches

C = conductance per unit area (1 sq ft) per deg F per hour

U = heat transfer per unit area per hour

H = total heat entry (or loss) per hour = Area $\times$ U

r_s = radius of outer surface of insulation

r_1 = radius of inner surface of insulation

r_2, r_3 = radii of intermediate surfaces if there is more than one material

t_a = surrounding air temperature

t_s = insulation surface temperature

t = operating or design temperature

$\Delta t = t_a - t$

Flat Surfaces.

One material

$$R = \frac{x}{k} \text{ and } C = \frac{1}{R}$$

$$U = \frac{t_a - t}{R + R_s}$$

(For heated equipment $U = \frac{t - t_a}{R + R_s}$

For condensation problems

$$\frac{t_a - t_s}{t_a - t} = \frac{R_s}{R + R_s}$$

$$\text{or } t_a - t_s = \frac{R_s(t_a - t)}{R + R_s}$$

More than one material

$$U = \frac{t_a - t}{R_1 + R_2 + \ldots R_s}$$

For temperature of an intermediate face

$$\frac{t_a - t_1}{t_a - t} = \frac{R_1}{R_1 + R_2 + \ldots R_s}$$

If heated equipment, the convenient form is

$$\frac{t - t_1}{t - t_a} = \frac{R_1}{R_1 + R_2 + \ldots R_s}$$

Cylindrical Surfaces.

U_s = unit heat transfer per square foot of outer surface of insulation

U_1 = unit heat transfer per square foot of inner surface of insulation

One material

$$U_s = \frac{t_a - t}{\frac{r_s \log_e \frac{r_s}{r_1}}{k} + R_s}$$

$$\text{and } U_1 = U_s \times \frac{r_s}{r_1}$$

The expression $\frac{r_s \log_e \frac{r_s}{r_1}}{k}$ takes the place of the simple R (or $\frac{x}{k}$) in the equation for flat surfaces because the area at one surface of the insulation is greater than at the other.

$r_s \log_e \frac{r_s}{r_1}$ is often referred to as the "equivalent thickness" and if much figuring has to be done on insulation applied to curved surfaces, it is worthwhile to work out a table of values.

Modified McMillan Equation. (In which x is the most economical thickness.)

For derivation of this equation see (3). In this form, it is assumed there is no significant thermal resistance aside from that of the insulation and the surface resistance.

$$x = \left(\frac{ak}{b}\right)^{1/2} - R_s k$$

$a = Y(t_a - t)M \times 10^{-6}$ where Y = hr operation/yr, M = cost per million Btu.

$$b = \left(\frac{I}{L}\right) + \left(I \times \frac{\text{Rate of Interest}}{2} \times \frac{(L+1)}{L}\right)$$

Where:

I = investment per square foot per inch

L = expected life in years.

The values of R_s are primarily useful when calculating surface temperatures to see if condensation will take place. They are also used when checking multi-layer insulation designs to see that the interface temperatures do not exceed the maximum temperature limit of a material.

For condensation calculations, we are nearly always dealing with comparatively low rates of heat transfer and must assume that the air movement over the surface is slight. In the case of outdoor insulation, a high wind reduces the surface resistance to so small a value that there is almost no temperature drop from the air temperature to the surface temperature, hence condensation will occur only in the rare and short periods when the relative humidity is not far below 100 per cent. This condition is no problem, so what has to be considered is comparatively high humidities occurring when there is little air movement, a situation that is quite common.

Table 1 gives a number of values for R_s. It has been the writer's practice to use $R_s = 0.65$ in condensation calculations.

Some examples of the use of the equations given follow, and several

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Croloy 1¼	(2% Cr, ½% Mo)
Croloy 2	(2¼% Cr, 1% Mo)
Croloy 2¼	(3% Cr, 1% Mo)
Croloy 3-M	(5% Cr, ½% Mo)
Croloy 5	(5% Cr, ½% Mo, 1½% Si)
Croloy 5-Si	(5% Cr, ½% Mo, ½% Ti)
Croloy 5-Ti	(7% Cr, ½% Mo)
Croloy 7	(9% Cr, 1% Mo)
Croloy 9-M	(18% Cr, 8% Ni)
Croloy 18-8-S	(16% Cr, 13% Ni, 3% Mo)
Croloy 16-13-3	(25% Cr, 20% Ni)
Croloy 25-20	

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TA-1568

TABLE 1. Values of surface resistance, R_s

	Flat surfaces and vessels over 6 ft 0 in. diam.					Insulated pipes			
Wind velocity U =	50	100	200	300	400	20	50	100	200
50 ft. per min.	0.60	0.54	0.46	0.43	0.40	0.70	0.64	0.57	0.48
1 mph	0.53	0.47	0.40	0.37	0.35	0.62	0.57	0.51	0.43
3 mph	0.43	0.39	0.34	0.32	0.30	0.53	0.49	0.44	0.36
5 mph	0.37	0.34	0.30	0.28	0.27	0.46	0.42	0.38	0.32
10 mph	0.31	0.28	0.25	0.24	0.23	0.37	0.34	0.31	0.26
20 mph	0.25	0.23	0.21	0.20	0.19	0.29	0.27	0.24	0.20

appeared in the January, 1950 issue of *The Petroleum Engineer*, page C-13.

Example 1.

Insulation of vessel, 10 ft 0 in.-diam, 22 ft 6 in. long, resting in horizontal position on three saddles. Primary purpose—process temperature control.

Probable useful life—10 years.

Conditions—Outdoors, steady state (cycle—on stream 30 days—1 day clean out)

Operating temperature, —20 F

Climatic data—Average summer conditions, air at 80 F, humidity 65 per cent. Peaks: Air temperature 100 F, humidity in the nineties early in the day. Maximum permissible heat entry 5000 Btu per hour.

First Approx.—Surface area = 864 sq ft so heat transfer rate cannot exceed about 5.8 Btu per hr per sq ft. Average $t_a - t = 100$ deg, therefore total thermal resistance must be no less than $\frac{100}{5.8} = 17.25$.

An insulation with a conductivity of approximately .30 has a resistance of 3.33 per inch, so between 5 and 6 in. is required. Commercial thicknesses are usually in even inches and, in view of the summer peak temperatures, the choice must be for the greater thickness. At the worst, $t_a - t = 120$ and using 6 in. thickness the transfer is $\frac{120}{6 \times 3.33} = 6.00 +$ Btu per sq ft per hr or 6.00 by 864 = 5185 Btu per hour or 103.7 per cent of the desired maximum. The process men say they will stand for the excess load during peak temperatures so it is only necessary to check for surface temperatures.

Under normal conditions, 1 in. of insulation for each 20 or 25 deg of overall temperature difference will prevent surface condensation, so 6 in. should be ample; but the maximum conditions given are fairly rough, so it will be well to see just what may be expected. Inside film effect, resistance of accessory materials and of the steel shell may be disregarded.

	Resistances	Proportions
6-in. insulation $\left(\frac{6}{.3}\right)$	20.00	96.85%
Outer surface	0.65	3.15
	20.65	100%

The surface temperature will be below the air temperature by 3.15 per cent of the overall temperature difference.

Average conditions:

t_a	$t_a - t$	$t_a - t_s$	t_s
80 F	100 F	3.15 F	76.85 F

Maximum conditions:

t_a	$t_a - t$	$t_a - t_s$	t_s
100 F	120 F	3.78 F	96.22 F

Dry bulb 100 F and surface temperature 96 F means the relative humidity must reach 88½ per cent before there is condensation. This shows that at maximum conditions there will be some condensation, but it will not be excessive and will not last long.

For these higher temperatures, the psychrometric charts are not entirely convenient. A quick way to determine the relative humidity is from a table of the thermodynamic properties of water at saturation such as appears in the *A.S.H. & V.E. Guide*. In this case, it is shown that the absolute pressure of water vapor at 100 F is 1.9334 in. Hg., while the saturated pressure at 96 F is 1.7124 in. Hg. Then, $\frac{1.7124}{1.9334} = .885$, or the condition of 100 F and 88½ per cent relative humidity will mean condensation on a surface at 96 F.

The average conditions were taken as $t_a = 80$ F and a relative humidity of 65 per cent. For this,

p_s at 80 F = 1.0323 in. Hg.

p_s at 77 F = 0.9352 in. Hg., then

$\frac{0.9352}{1.0323} = .905$, so there will be no condensation below a relative humidity of 90½ per cent on a surface at 77 F.

Example 2.

Insulation on 6 in. pipe line, temperature —25 F, length of line 350 ft, temperature rise of contents not to exceed one degree. Fluid transmitted has specific heat of 0.88 and specific gravity of 0.92. Rate of flow 300 gpm. Location—exposed to weather, average temperature 65 F.

Contractor has proposed use of 3 in. thick pipe insulation or as an alternate 4 in. thick. Heat transfer rates stated to be respectively .259 and .228 Btu per hour per linear foot per degree temperature difference. The difference in cost is appreciable.

350 ft of 6 in.-pipe holds approximately 525 gal.

525 by 8.33 by .92 by .88 = 3540 Btu to raise temperature one degree.

Rate of flow of 300 gpm indicates 1.75 minutes for 525 gal to traverse the pipe.

.259 by 90 by 350 = 81,600 Btu per hr or 1360 Btu per min.

1360 by 1.75 = 2380 Btu, so the lesser thickness is adequate.

Example 3.

The following equipment is to be insulated and it is desired to set up tabulation of insulation requirements for bidders.

Conditions: All equipment save items D, I, J, and L are exposed to weather.

Average summer temperature, 75 F. Average relative humidity, 65 per cent with periods when 80 per cent relative humidity will obtain. Design for $t_a - t_s = 6.0$ max.

Primary purpose of insulation on all items, process temperature control. Secondary, but of major importance, prevention of frosting or condensation on surfaces tending to damage protective finishes and impair value of insulation. Economic thickness of lesser importance but unit heat entry should not exceed 10. Btu per hour per square foot as refrigeration not unlimited.

Materials must withstand clean out temperatures of 250 F.

During application, the use of hot asphalt or any material requiring the use of open flame heaters is not permissible.

Some sulfur compound gases in the air may be expected.

Cold insulation schedule.

Item	Number		Diam	Temp F	Suggested thickness
A	1	Gas receiver	10′—0″	—30	5″
B	1	Filtrate receiver	6′—6″	—30	5″
C	1	Feed tank	5′—0″	—30	5″
D	2	Flash Drums	4′—10″	—32	5″
E	1	Separator	4′—6″	—15	4″
F	1	Chiller (shell and tube)	4′—0″	—30	5″
G	1	Exchanger	9′—0″	35	2″
H	1	Solvent chiller	3′—6″	—30	5″
I	2	Dble. Pipe Exchangers	Flat	20	3″
J	2	Dble. Pipe Chillers	Flat	—30	5″
K	1	Storage Drum	4′—0″	—15	4″
L	2	Filters	12′—0″	—28	5″

FIG. 5. Insulation thickness required to keep outer surface of insulation within 6 F of surrounding air temperature (conductivity of insulation taken as .301).

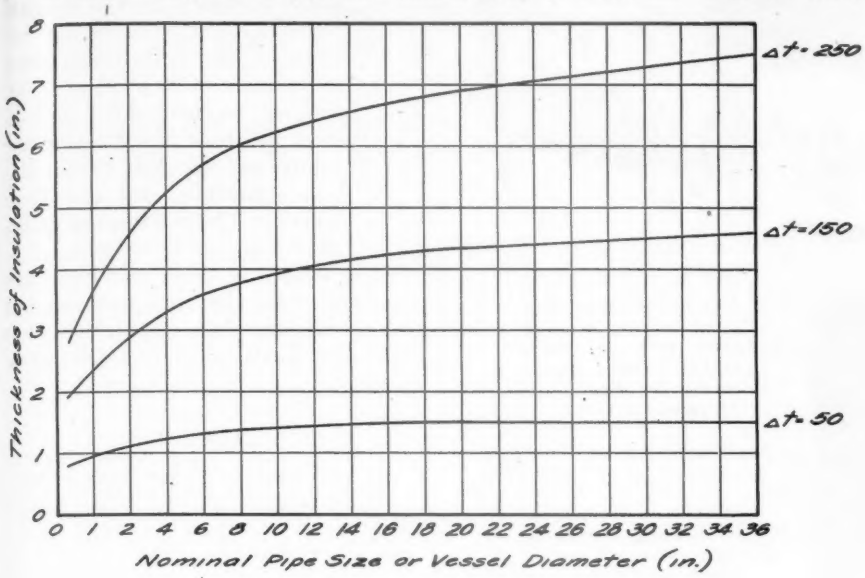
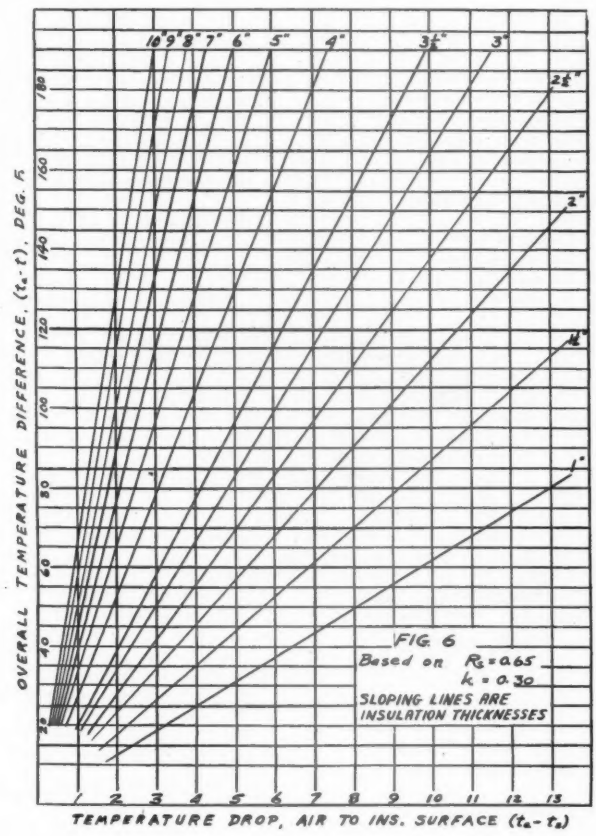


FIG. 6


OVERALL TEMPERATURE DIFFERENCE, (ta-t), DEG. F
TEMPERATURE DROP, AIR TO INS. SURFACE (ta-ts)
FIG. 6
Based on Rs=0.65
k=0.30
SLOPING LINES ARE INSULATION THICKNESSES

To check against the conditions stated, it is sufficient to make a couple of calculations and examine the other items for consistency, as the sizes of vessels are large enough to make unnecessary the refinement of using "equivalent thickness" values. (See Fig. 5).

Item D.

Maximum temperature difference = 75 — (—32) = 107 deg.

Mean temperature, 75 — 53 = 22 F

k can be taken as 0.3.

$$U = \frac{107}{\frac{5.}{0.3} + 0.65} = \frac{107}{17.35} = 6.16.$$

If temperature goes to 100 F, $t_a - t$ will be 132.

$$\frac{132}{17.35} = 7.61$$

For surface temperature, $t_a - t_s =$

$$\frac{.65 \times 107}{17.35} = 4.0 \text{ and } 75 - 4 = 71 \text{ F.}$$

If air temperature rises 25 deg, $t_a - t$ increases 23.3 per cent and $t_a - t_s$ becomes approximately 5.0.

Other item are tabulated—

Item	ta - t	t	Insulation thickness	Degrees per inch	U
A, B, C, F, H, J	105	—30F	5"	21.	....
D	107	—32	5"	21.4	6.16
E	90	—15	4"	22.5	6.43
G	40	35	2"	20.	....
I	55	20	3"	18.3	....
K	90	—15	4"	22.5	....
L	103	—28	5"	20.6	....

All are close enough so that no further check is necessary on heat transfer nor surface temperature.

Points to check in specifications:

1. Weatherproof finish on A, B, C, E, F, G, H, K.
2. Check upper temperature limit (min. 250 F) of any insulation or adhesive proposed.
3. If adhesives to be used, check for flammability *(no kettles)*.
4. All surface bands or straps to be stainless steel.
5. Consider advisability and comparative price of weatherproof asbestos cement type finish compared to jackets or coatings.
6. Exposed metal to be painted.
7. Bidders to particularize how they intend to flash around metal that projects through insulation. Example: Center flanges on L.

Notes.

In example 3, there were indicated several points to be checked in preparing or analyzing specifications, that were pertinent to the hypothetical case involved.

There are some others of interest—

1. It is not desirable to apply insulation to vessels and small tanks with an adhesive. Mechanical securement is necessary in any case, and where bevelled or curved lags are used, it is better to apply them dry, temporarily held under a spring band, using the last lag as a sort of wedge to tighten all joints.
2. The use of adhesive on tank insulation is acceptable but care must be demanded that joints between blocks or sheets are tight. Once a sheet or block is "stuck", it cannot be forced tighter against its neighbor.
3. The effect of wide joints on heat transfer is considerable, even though they be filled with some moisture resistant compound. The conductivity of asphalt is about 5.0 according to McAdams text, or around 15 times that of any good insulant. While the area of the joints is small proportionately, considerable heat will flow through them. A

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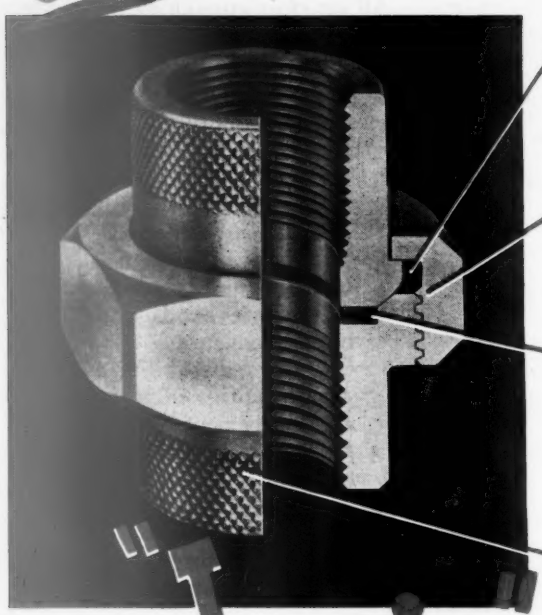

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Fig. 342

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little figuring will show that joints 1/16 in. thick will transmit enough heat to raise the total transfer some 10 to 12 per cent while ⅛ in. thick joints show an increase of 20 to 25 per cent. The way to check this is to consider the heat flow through the joints and through the insulation separately and add them together. The two thermal resistances may not be averaged.

The following table and chart are convenient for checking purposes, but do not take the place of psychrometric tables or charts for careful determinations.

TABLE 2

Dry bulb Deg F	Approximate dew point depression in deg F — % Rel. humidity — 90	80	70	60	50
80.....	3	6	10	14.5	19.5
70.....	3	6	10	14	19
60.....	2.8	5.8	9.5	13.7	18.1

Appendix A

McMillan equation for economic thickness of insulation:

In this modification of the original the surface resistance, R_s, takes the place of R, as by hypothesis there is no significant thermal resistance save the insulation and the surface effect.

Let the cost of heat loss, per square foot per year $= M = \dfrac{a}{\dfrac{x}{k} + R_s}$

Let the cost of insulation, per square foot, per year per inch $= b$

Let the cost of insulation per square foot per year $= N = bx + C$

Total cost per year, per square foot

$$= M + N = \frac{a}{\frac{x}{k} + R_s} + bx + C =$$

$$\frac{ak}{x + R_s k} + bx + C$$

Differentiating and equating the first derivative to zero:

$$\frac{dy}{dx} = \frac{-ak}{(x + R_s k)^2} + b = 0 =$$

$$-ak + b(x + R_s k)^2 = 0$$

or $ak = b(x + R_s k)^2$

Dividing through by 6 and extracting the square root of both terms,

$$\sqrt{\frac{ak}{b}} = x + R_s k$$

so for the most economical thickness

$$x = \sqrt{\frac{ak}{b}} - R_s k$$

a, b are defined in the article.

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1. P. Nichols, Bureau of Mines, Pittsburgh. "The Economic Thickness of Insulation in the Refrigerating Field." Published as part of Circular No. 1, American Society of Refrigerating Engineers, 1924.
2. L. B. McMillan, "Heat Transfer Through Insulation in the Moderate and High Temperature Fields." Proc. A.S.M.E., December, 1926.
3. J. F. Stone, "Insulation for Low Temperatures." Journal, A.S.R.E., in "Refrigerating Engineering," July, 1943.

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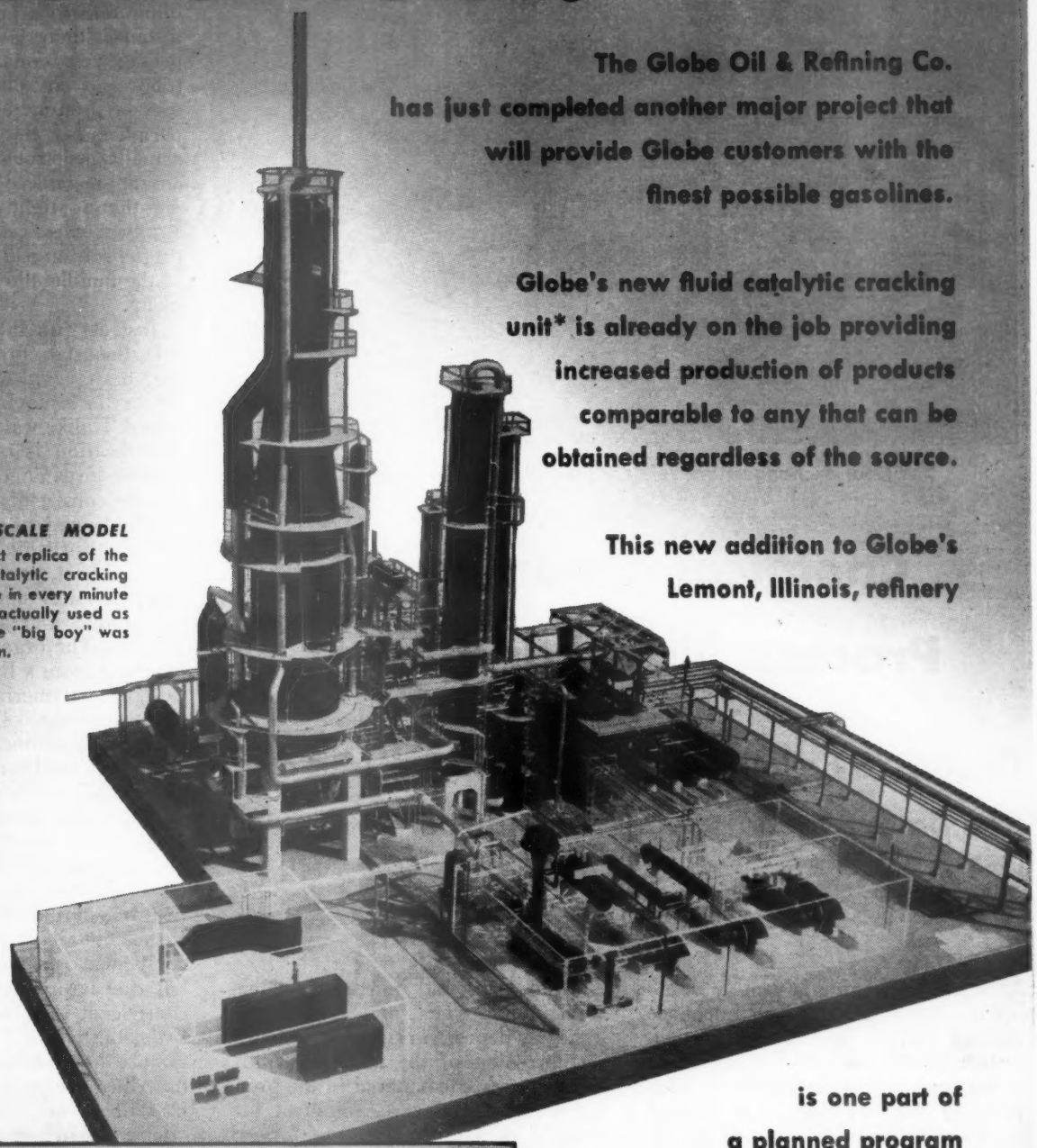

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Chemical Cleaning of Process Side Equipment

Deposit to Be Removed, Solvent to Be Used and Equipment to Be Cleaned, Controlling Factors

C. H. GROOM*

CHEMICAL cleaning is rapidly developing into a standard maintenance tool in refinery operations, particularly in the removal of water deposited scales and corrosion products. This phase of chemical cleaning as applied to refineries is well covered in the literature. The most difficult deposits to remove, however, are the process side or organic deposits, especially those encountered on the shell sides of tube and shell units. This article is directed to the discussion of recent advancements in chemically removing process side deposits.

Process Side Deposits

The deposits encountered in refinery equipment fall into three classes: Inorganic materials, organic materials, and mixtures of both. Inorganic deposits are found in equipment that is handling water and are formed either by deposition from the water or by corrosion of the metal, or both. The deposits encountered in the process sides of refinery equipment are organic in nature. They are formed essentially by the decomposition or polymerization of petroleum hydrocarbons on the contact surfaces of the various refinery units. Mixtures of organic and inorganic deposits also are encountered, the inorganic portions generally composed of iron oxides and sulfides, copper oxides and sulfides, and other metallic salts.

The organic deposits encountered in the shell side of tube and shell units of process equipment usually are extremely difficult to remove. This is true because as a rule the units are operated until the deposits become thick and crack off the tubes. The loosened deposits then fall down into the tube bundle, sometimes completely filling the annular space between the tubes. The resulting higher operating temperatures under these circumstances cause carbonizing of the deposit, oftentimes to a high degree. In such instances there is practically no fluid passageway remaining between the tubes and any chemical solvent that may be used merely flows around the periphery of the bundle and never actually penetrates into the bundle to any appreciable depth. On those bundles that are tightly packed with scale, however, chemical cleaning using the proper solvent will clean the periphery of the bundle allowing it to be pulled easily.

Just as with the removal of water side deposits, process side deposits first must be identified before much success in removing them can be obtained. Unlike water side deposits, the identification is of a general nature because organic or process deposits usually consist of not one or two but hundreds and possibly thousands of different organic compounds. The effect of heat, pressure, moisture, and other physical and chemical factors can produce a great variety of organic deposits. The organic deposit may be anything from a light volatile fluid to a highly polymerized material or decomposed cokelike material which appears to be untouched by the solvents commonly used for chemical cleaning.

A process side deposit usually is identified by breaking it down into three rough classifications: Oil soluble, oil insoluble, and inorganic. The oil soluble component of the sample is readily determined by extraction with carbon tetrachloride, the inorganic component is assumed to be the ash left after ignition and the oil insoluble component is obtained by difference. From the physical appearance of the sample the oil insoluble component is described as being slightly polymerized or carbonized. Here the term, "polymerized", is used loosely to designate the magnitude of the material's molecular weight. The inorganic components of the deposit usually are composed of the oxides and sulfides of iron, copper and zinc.

As a typical process side deposit analysis, a sample taken from the tube side of a tube and shell exchanger handling desalted Illinois crude oil at 300 F was analyzed as follows:

Organic matter soluble in carbon tetrachloride	31 per cent
Organic matter insoluble in carbon tetrachloride	8 per cent

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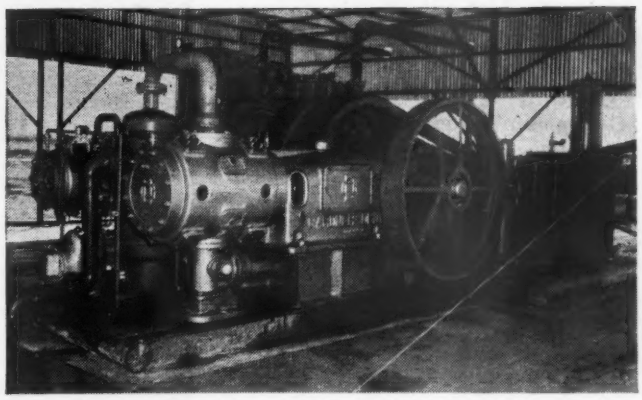

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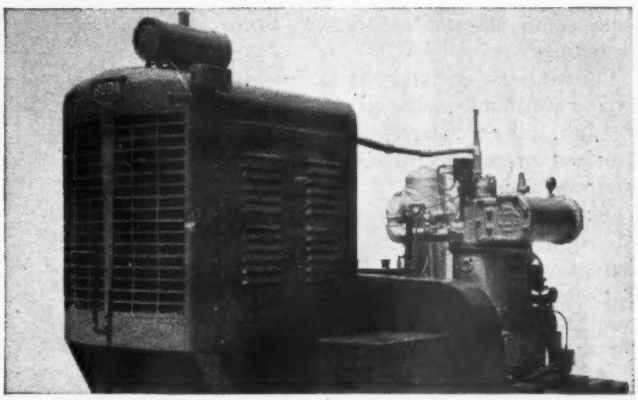

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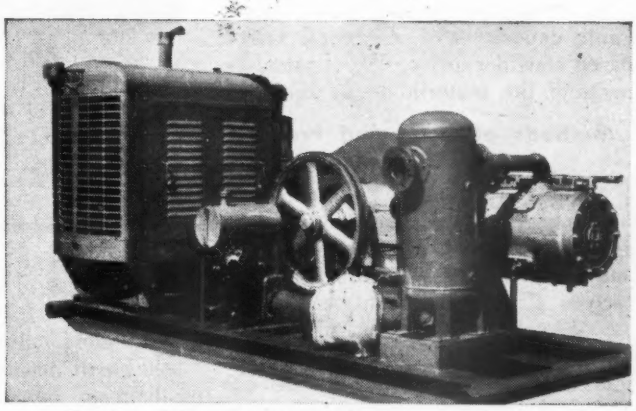

Engine driven 8 x 9 gas booster compressor.

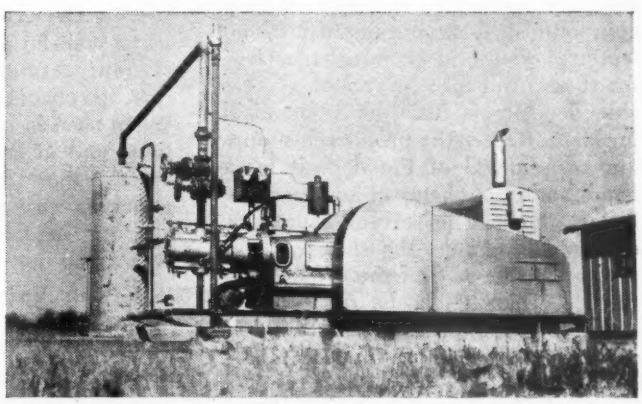

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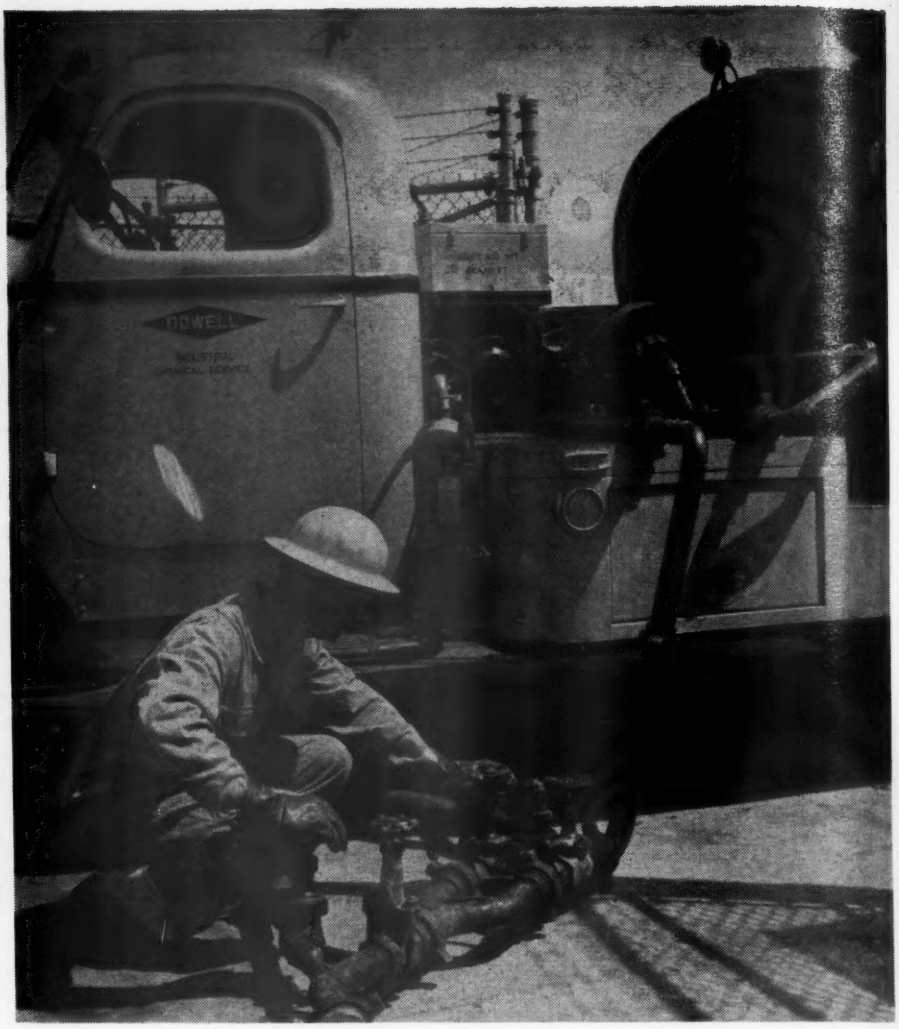
FIG. 1. Mobile centrifugal pump and piping for high velocity circulation.



Inorganic matter soluble in hydrochloric acid .....49 per cent
Inorganic matter insoluble in hydrochloric acid .....12 per cent
Total solubility in hydrochloric acid and carbon tetrachloride—80 per cent

Typical of the types of deposits encountered in the various types of refinery process equipment are the following:

Depropanizer—Polymerized organic with considerable iron oxides.

Fractionator—Mostly iron oxides with small amount of organic. Some iron sulfide.

Absorber—Mostly iron oxides mixed intimately with oil.

Light oil exchanger—Highly polymerized organic with small amounts of iron oxides.

Catalyst coolers—Intimate mixture of equal amounts of oil and iron oxides.

Catalytic cracker condenser—Intimate mixture of iron oxides, iron sulfides, polymerized organic in oil.

Ammonia condenser—Mostly iron oxides with small amount of oily sludge.

In every case the analysis of the organic deposit is of a general nature based considerably on the physical aspects of the material to be removed.

Methods of Removing Process Side Deposits

Similar to any other chemical cleaning operation, the entire work of removing process side deposits is predicated upon consideration of three factors: (1) the deposit to be removed, (2) the solvent to be used, and (3) the unit to be cleaned. Each of these factors must be considered before any chemical cleaning operation can be designed.

Because process side deposits usually are mixtures of many organic compounds, it is impractical to attempt to write out chemical reactions for them. And the removal of process side deposits is not just a chemical problem. Rather the problem becomes one of removal of the deposit by a combination of chemical and mechanical methods. The solvent usually is designed to change the chemical and physical properties of the organic deposit so that it can be removed by hosing or some other means of washing. There are three general tools available to the engineer faced with process side deposit removal. They consist of the use of strong oxidizing solvents, high velocity circulation of the solvents through the unit, and modification of the tube and shell unit itself so that it can be more easily cleaned.

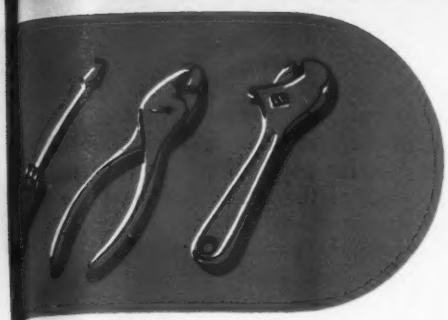
Oxidizing Solvents

As previously mentioned, the chemical means of removing process side deposits is to change their physical and chemical characteristics so that they will dissolve or slough, enabling them to be washed from the unit. Chemicals that will do this job the best are the stronger oxidizing solutions of either alkaline or acid type. Among the oxidizing agents available which can be used effectively are potassium permanganate, sodium chlorate, the chromates, and chromic acid. When used in high enough concentrations and at sufficiently high temperatures, these are very effective in attacking process side deposits and altering them sufficiently so they can be washed out of the unit.

High Velocity Circulation

Many times in using one or more of the oxidizing solvents or other chemical solvents, the process side deposits are removed from the surfaces readily but they are not readily emulsified or dispersed in the solvent. Therefore, they have a tendency to settle out and lodge in the annular spaces within the vessel and can create a more severe condition than existed when they were in place. Circulating the solvent aids greatly in their removal but generally the equipment used in the process involves such a small pump that practically no velocity is obtained in circulating. Here the answer is to use high capacity pumps. It then is possible to obtain high solvent velocity and to wash out the sloughed materials. For example, a type of equipment that is difficult to clean is the shell side of slurry condensers on fluid catalytic units. The deposits found on the outside of the tubes are generally of a soft black oily nature containing some iron sulfide. Strong oxidizing solutions seem to attack these deposits readily giving good disintegration but resulting in the problem of packed tube sheets.

In one instance two of these units were cleaned effectively and easily by high velocity circulation. Two mobile chemical cleaning units were placed near the two condensers. Each unit was equipped with a 150 gpm centrifugal pump, as shown in Fig. 1. Two-



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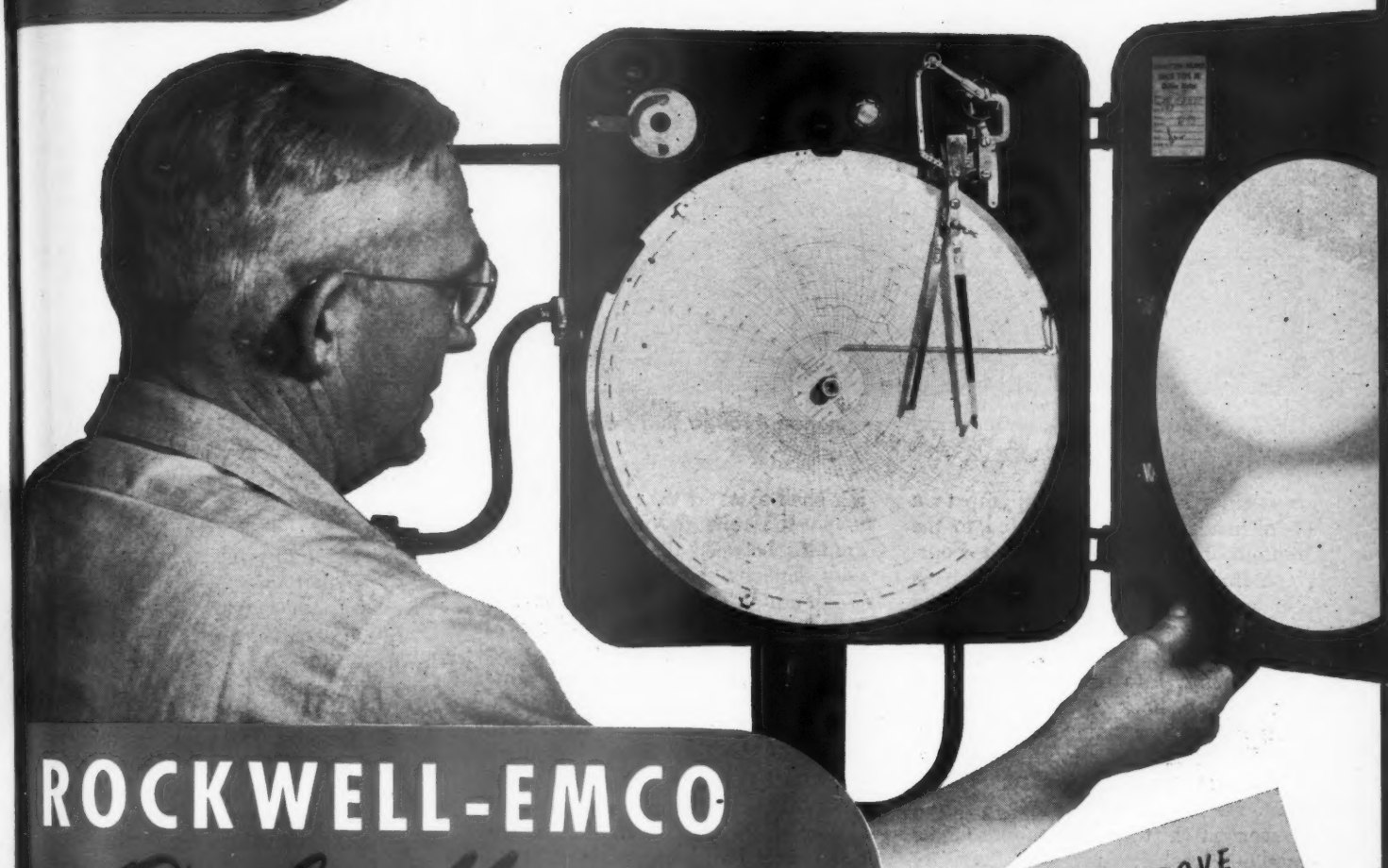

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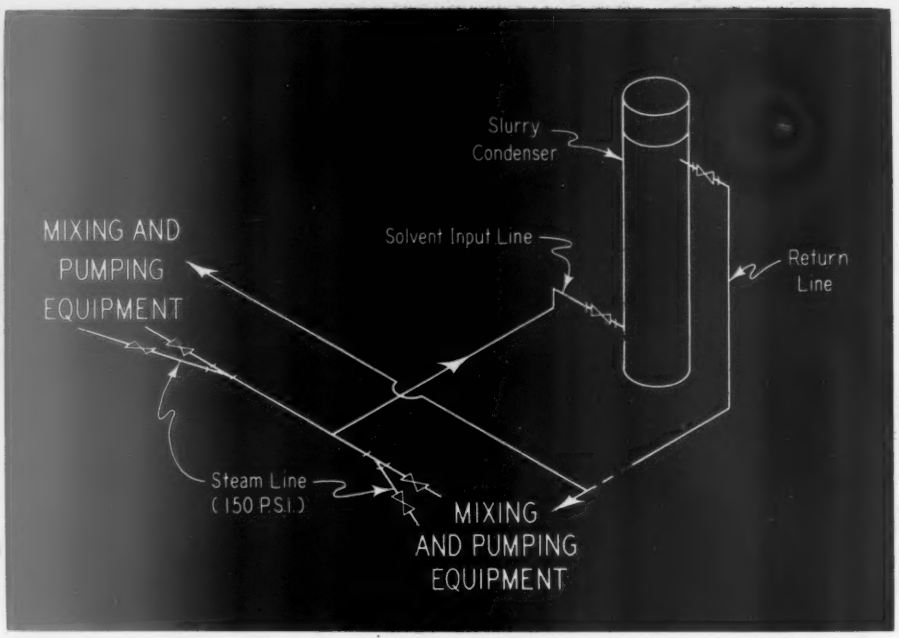

FIG. 2. Hook-up used for high velocity circulation through slurry condensers.

inch lines ran from each pump to a 4-in. header, which connected to the bottom of the shell of each unit. Four-inch lines returned from top of each condenser to both mobile units. An oxidizing type of solvent was then pumped by both pumps through the 4-in. header into one condenser and out the top, back to the trucks. The temperature was maintained at 190 to 200 F by steam injection heaters. Fig. 2 illustrates the hook-up used. The solvent was circulated through one condenser at a time. Employing this method, the shell sides were effectively cleaned. The results were attributed to using a strong oxidizing solvent which attacked the heavy deposits and then to the rapid velocity which allowed the solvent to penetrate deep into the bundle and wash out the sloughed material.

One of the major problems in cleaning shell sides of tube and shell units is that the units are operated until the annulus between the tubes is packed with deposits. In attempting to clean these units with solvent it has been found that the solvent generally skirts the periphery of the bundle and never gets into the center to do its real work. A suggested means of overcoming this problem is to apply the solvent at the center of the bundle so that it can work its way outward through the deposits. This would necessitate modification of the unit itself. One suggestion* that has been made is that a perforated tube could be built into the center of the bundle and rolled into the front tube sheet as illustrated in Fig. 3. When the unit was in operation this perforated tube would be blanked-off from the unit by some type of cap or plug at its inlet end. A corresponding opening in the head of the unit would be available and blanked-off also during operation. To prevent plugging of the perforated tube during operation of the unit, a smaller tube could be inserted in the center of the perforated tube which would cover the perforations and prevent entrance of deposits into the pipe. This liner would be removed during the cleaning operation.

When the unit was to be chemically cleaned, the blank flange on the head could be removed and also the plug from the perforated tube. A solvent inlet pipe then could be inserted through the opening in the head into the open end of the perforated tube. As shown in Fig. 4 this then would result in a solvent line discharging directly into the center of the bundle where the deposits are heaviest and in such a manner that the solvent would have to contact all of the deposits. It is believed that this suggested modification of a process unit has not been tried as yet. It is presented here with the thought that it might lead to other ideas on modifying tube and shell units so that they can be chemically cleaned more easily.

In summarizing, it is believed that process side deposits offer one of the most difficult chemical cleaning problems and also one that, if solved, would be of great value to refinery operations. The three methods that now appear most applicable to the removal of process side deposits from shell sides are: (1) use of strong oxidizing solvents to change the physical and chemical characteristics of the original deposits, (2) a means of putting solvent directly into the center of the bundle so that the solvent will readily contact all deposits, and (3) use of high capacity pumps and large circulating lines so that high velocities are obtained to wash out the disintegrated deposits.

*H. W. Ross, Sohio Petroleum Corporation, Calgary, Alberta.

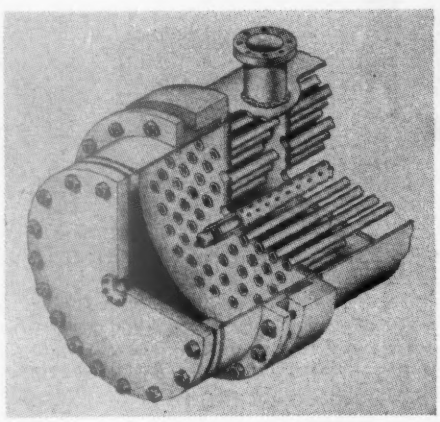

FIG. 3. Suggested placement of perforated tube at center of tuble bundle to pump solvent.

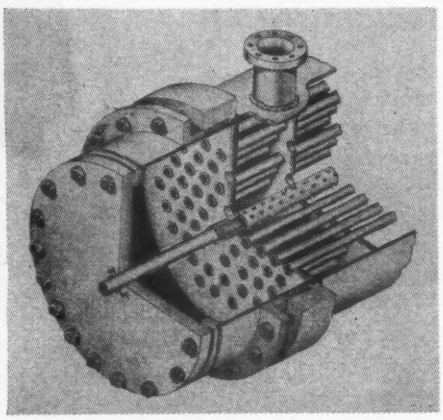

FIG. 4. Exchanger provided with perforated tube ready for chemical cleaning.

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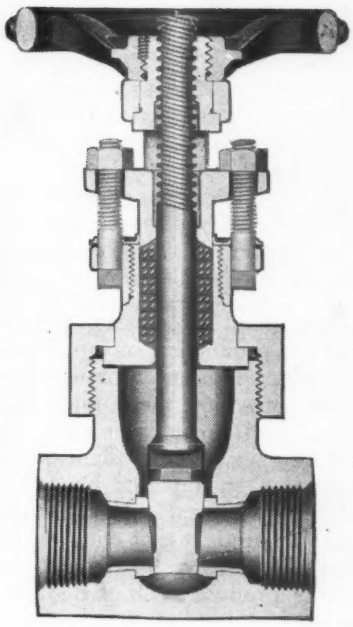

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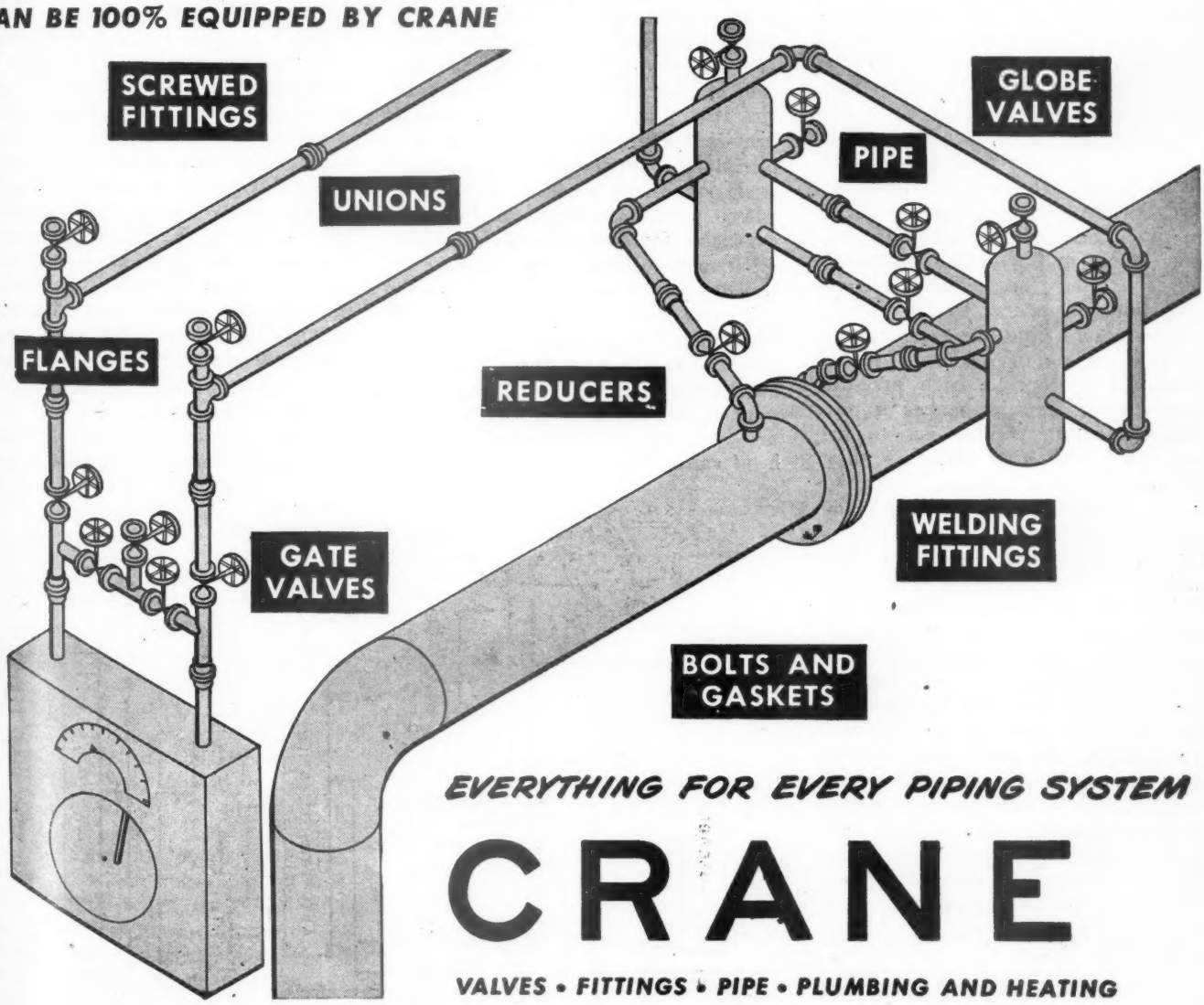

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Processes for Natural Gasoline Plants And Associated Systems

Alan S. Glendening* and Charles F. Sanderson*

Any plant processing natural gas for the production of liquid products is referred to as a natural gasoline plant provided the liquids are produced without chemical reaction. "Natural gasoline" plant accurately describes such plants built 20 years ago, as "natural" was the only important product that could be so produced. Today, however, gasoline plants produce such varied products as natural gasoline, butanes, propane, ethane, iso-butane, and iso-pentane. When distillate is processed along with gas, such additional "heavy" products as motor fuel, kerosine, naphtha, diesel oil, and solvents may be produced. With the addition of gas treating and sulfur recovery systems, elemental sulfur may be produced as a byproduct of sour gas processing.

Residue gas may itself be regarded as a plant product. Stripped of hydrocarbons that tend to condense in pipe lines, relieved of water that may freeze in lines, such residue is ideally suited for delivery to gas pipe line consumers. Under circumstances where pipe line consumption is not possible or desirable, installation of appropriate high pressure compression facilities makes it possible to return residue gas to the reservoir. Such a plant is then referred to as a "cycling" plant.

As might be expected from the above, considerable variation exists from one plant to another. Virtually all, however, may be classified in two groups according to the method used to liquefy the production. Most plants accomplish this by oil absorption, i.e., by contacting the incoming gas with a kerosine-like oil that picks up the heavier fractions in the gas. Other plants use refrigeration in conjunction with compression to take the gas below its hydrocarbon dew point and thereby drop out the heavy ends. Various processes of these two types will be considered in detail.

*Sanderson-Glendening, Consulting Engineers, Houston, Texas.

EXCLUSIVE

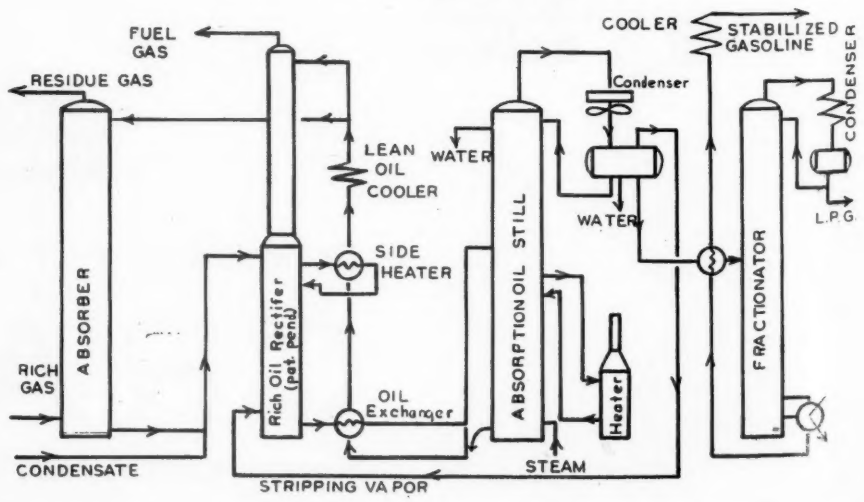
Oil Absorption

Fig. 1 is a simplified diagram of the absorption cycle employed at the Cymric field plant in Kern County, California operated by Honolulu Oil Corporation. This plant possesses a number of features typical of recent trends in gasoline plant design. The process is as follows: Rich gas is compressed (compressors not shown) and passed through an absorber where it is contacted with "lean" oil. "Rich" oil from the base of the absorber, containing plant production plus considerable undesirable methane and ethane, is stabilized in a "rich oil rectifier". In this column the methane and ethane in the rich oil is removed overhead by the application of heat and stripping vapors in the lower section; propane and heavier are retained by injecting lean oil into the upper section. De-ethanized rich oil then passes to the still where plant production is removed overhead for final product fractionation, and lean oil from the base is cooled by exchange and is returned to the absorber and rectifier. Product fractionation is performed in a single tower, LPG being produced overhead and natural gasoline at the base. Stripping vapors for the rich oil rectifier are obtained as uncondensed overhead vapor from the still.

Since the drop in propane prices early last year (1949) it has become generally unprofitable for small independent plants to produce propane as a separate product. (Most propane is being produced today by large gasoline plants under long term contract with refineries, chemical companies, etc.) Rather than design a plant for the maximum propane recovery consistent with the market value of propane as was the usual case two or three years ago, the present trend is to set a reasonable butane recovery and then to design for the maximum propane that may be blended with butane to form a salable LPG. Thus, propane is not produced as a separate product. This seems to have been the approach used in the design of the Cymric plant where design was for about 20 per cent propane and 60 per cent butanes recovery during initial operation. (Higher per cent recoveries are to be expected later as gas throughput declines over the years.) Moderate recoveries such as these make possible considerable simplification as compared with most of the high recovery plants built during recent years.

Rich Oil Stabilization. The rich oil rectifier shown in Fig. 1 is one of a variety of rich oil stabilization schemes that have been adopted since

FIG. 1—CYMRIC ABSORPTION PLANT



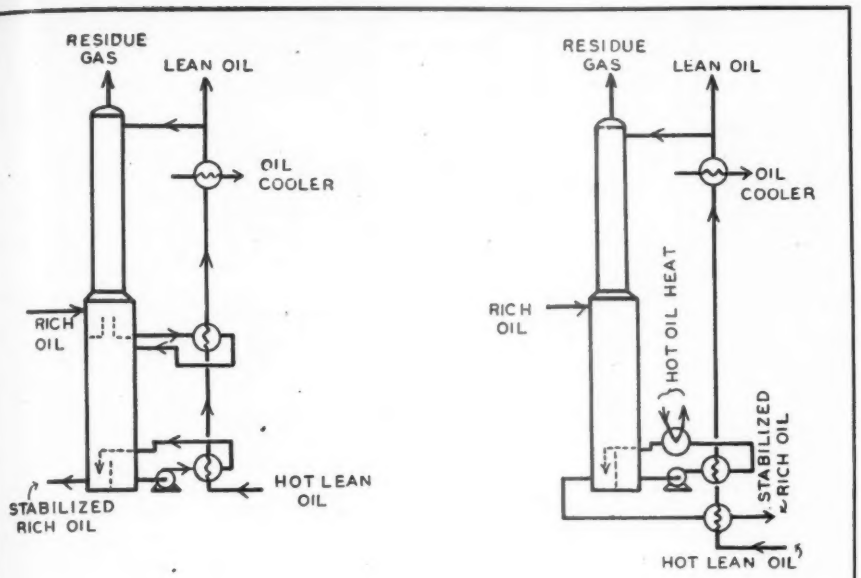


FIG. 2A FIG. 2B

RICH OIL STABILIZING ARRANGEMENTS

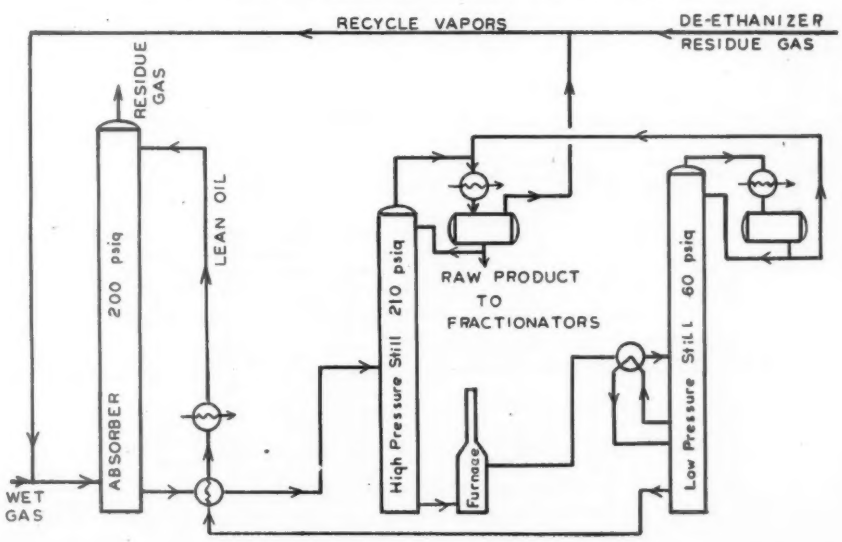
the war. Its purpose is to eliminate unwanted methane and ethane economically while preventing an attendant excessive loss of propane. The specifications of this unit at Cymric, for instance, required retention of 90 per cent or more of propane in the entering rich oil, and elimination of light ends down to an inclusion of 2½ per cent of ethane in the retained propane. Figs. 2a and 2b show two other rich oil stabilizing arrangements in recent plants. That at Barnsdall's Newhall-Potrero plant (Fig. 2a) is reboiled at the base as well as at the side. At Warren Petroleum's Maysville plant (the central plant of the three Garvin County, Oklahoma plants) oil is stabilized with the arrangement shown in Fig. 2b. Here reboiling is performed only at the base and heat is applied partly by lean oil to rich oil exchange and partly by a separate hot oil heating system. (Hot oil rather than steam is used for heating throughout this plant.)

There seems to be a considerable difference of opinion concerning the relative effectiveness of these various rich oil stabilizing schemes. Those who favor the side reboiling arrangement (Figs. 1 and 2a) argue that by exchanging lean oil against relatively cool rich oil a few trays below the feed, the temperature of lean oil to the coolers is kept quite low, the heat load on the oil coolers reduced, and thus the overall thermodynamic efficiency of the system enhanced. Those who oppose side reboiling argue that it interferes with the fractionation being performed (or to put it differently, nullifies the effect of some of the trays) and that the thermodynamic advantage described above is more than cancelled by an increase in oil circulation.

In some plants, (Fig. 1, for example), rich oil is de-ethanized effectively in the rich oil stabilizer, making further de-ethanization facilities unnecessary. In others, the designers have seen fit to de-ethanize the rich oil only partially (the stabilizer then being sometimes referred to as a demethanizer); and in such cases a fractionating de-ethanizer column must be included among the product fractionators to guarantee a sufficiently low vapor pressure propane or LPG. In this connection, there seems to be some evidence that wherever high plant recovery of propane is required, designers avoid putting the entire de-ethanizing load on a rich oil stabilizer. This is the case at Stanolind's Elk Basin plant in Wyoming (propane recovery apparently of the order of 75 per cent) and Sun's Starr County, Texas plant (80 per cent design recovery). Both of these plants have rich oil demethanizers and conventional de-ethanizer columns as well.

Two Stage Absorption Oil Distillation. Rich oil stabilizers eliminate all or most undesirable methane and ethane at an early point in the process, thereby simplifying process details downstream. Another approach to this problem is to allow some or all of the absorbed methane and ethane to remain in the rich oil but to keep these light ends "under control", so to speak, by operating a two-stage absorption oil distillation system. Such an arrangement is shown in Fig. 3, which is a simplified drawing of the Shell TXL plant process. Rich oil from the absorber is heated and partially stripped in a "high pressure still." Enough light ends remain in the absorption oil to maintain vapor pressure in the base of this still. These light ends are then taken overhead in a "low pressure still", totally condensed, and pumped into the HP still overhead. The purpose of this two-tower system is to obtain simultaneously the advantages of a high pressure single still (easy condensation of the raw product overhead) and of a low pressure single still (low stripping steam requirement).

FIG. 3—TWO STAGE ABSORPTION OIL DISTILLATION



Note that in Fig. 3 the non-condensable HP still overhead vapor, consisting largely of propane and lighter, is recycled to the absorber. This is a very neat, simple system but is possible only where the main absorber may operate at a moderate pressure. Where the main absorber must operate at above 200 to 250 psig, it is not likely to be desirable to recycle in this fashion. Instead a reabsorber will usually be installed between the main absorber and the HP still (see Fig. 4); this reabsorber handles gas flashed from high pressure rich oil as well as recycle gas from the still overhead.

Where extremely high propane recovery is desired, a two-stage distillation system may be preceded by a rich oil demethanizer. This is true of the Sun Starr County plant.

Process Heating and Cooling. Fig. 1 exhibits two other points of general interest: (1) air cooling is used at one point, and (2) a direct fired heater provides all heat for absorption oil distillation.

The air-cooled unit is used for primary condensation of the still overhead. This is an instance of a very considerable trend. Many recent plants have been built where water was extremely scarce or poor in quality. Thus, water treating and/or transmission costs may be reduced substantially by replacing high temperature duties with air cooling. It's probably unwise to generalize with regard to the substitution of water cooling by air cooling, but roughly speaking it seems that air cooling is at least as satisfactory as water cooling for duties requiring summer time process temperatures of about 130 to 140 F or higher. This applies in regions with 100 to 110-deg maximum ambient temperature. Among gasoline plant equipment that may be air-cooled according to this criterion are still primary condensers, engine jacket water coolers, some fractionator condensers, part of the gas cooler load (if any) and refrigerant condensers (if any). Some recent plants that have made extensive use of air-cooling are Barnsdall's Newhall-Potrero plant (California), the Carthage Corporation plant, and Coronado's Artesia, New Mexico plant.

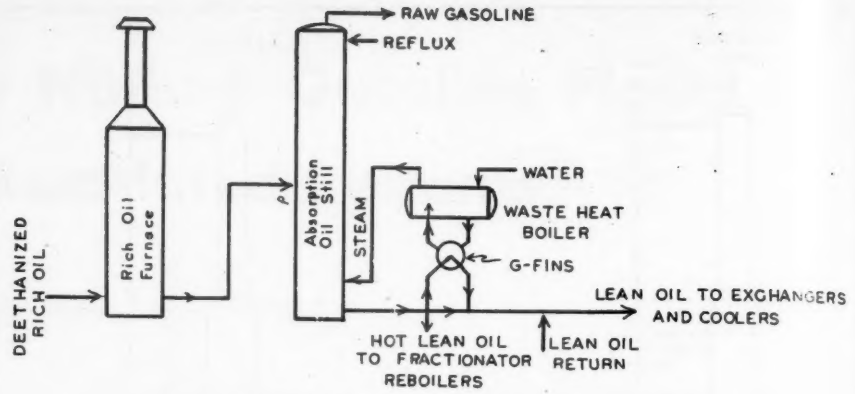


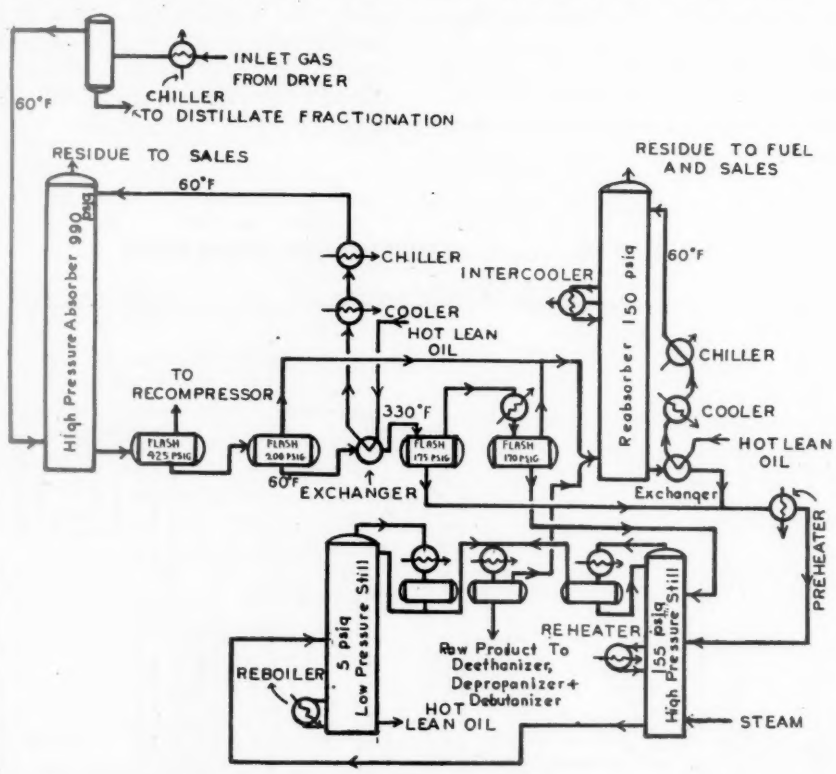
FIG. 5—NEWHALL POTRERO HEATING SYSTEM

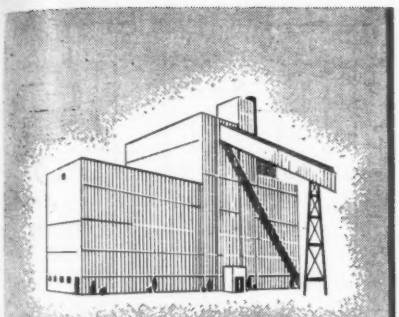
The use of direct-fired heaters and furnaces also reduces water problems. In addition, high process temperatures can be obtained by furnace heating without the use of high pressure equipment. With the post-war trend toward high pressure absorption oil distillation, such high temperatures help avoid large stripping steam requirements. Thus, in Fig. 1 an absorption oil is distilled at 115 psig as compared with normal operation before the war of perhaps 50 to 60 psig.

There are a variety of ways to apply furnace heating in a gasoline plant. In Fig. 1 heat is applied only to absorption oil distillation; the furnace acts as an absorption oil still side reboiler and rich oil feed to the still is preheated by exchange with lean oil. Other services are heated by steam. In other plants where, presumably, water is very scarce or of poor quality, hot oil heat has been extended to all services. At Barnsdall's Newhall-Potrero plant (Fig. 5), for instance, all process heating is applied to the rich oil feed to the still and a side stream of hot lean oil from the base of the still reboils all the fractionators. Stripping steam for the still is produced in a waste heat boiler consisting of tanks and G-fin sections; these sections are heated by another hot lean oil side stream. No high pressure steam is available in this plant for pumping, so high pressure gas is warmed with hot oil (not shown) and supplies pumping energy prior to being used as fuel.

Most gasoline plants using hot oil heat are designed with interlocked absorption oil and process heating; that is, furnace heat is applied to rich oil and a side stream of hot lean oil

FIG. 4—REFRIGERATED ABSORPTION WITH TWO-STAGE DISTILLATION





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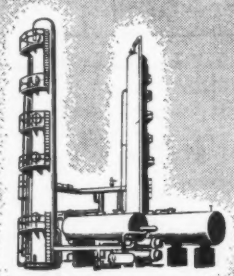
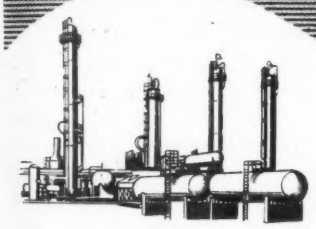


CHEMICAL DIVISION



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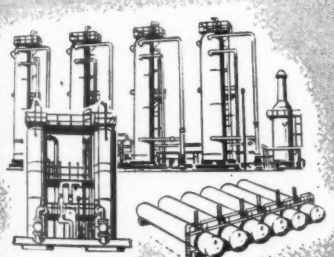

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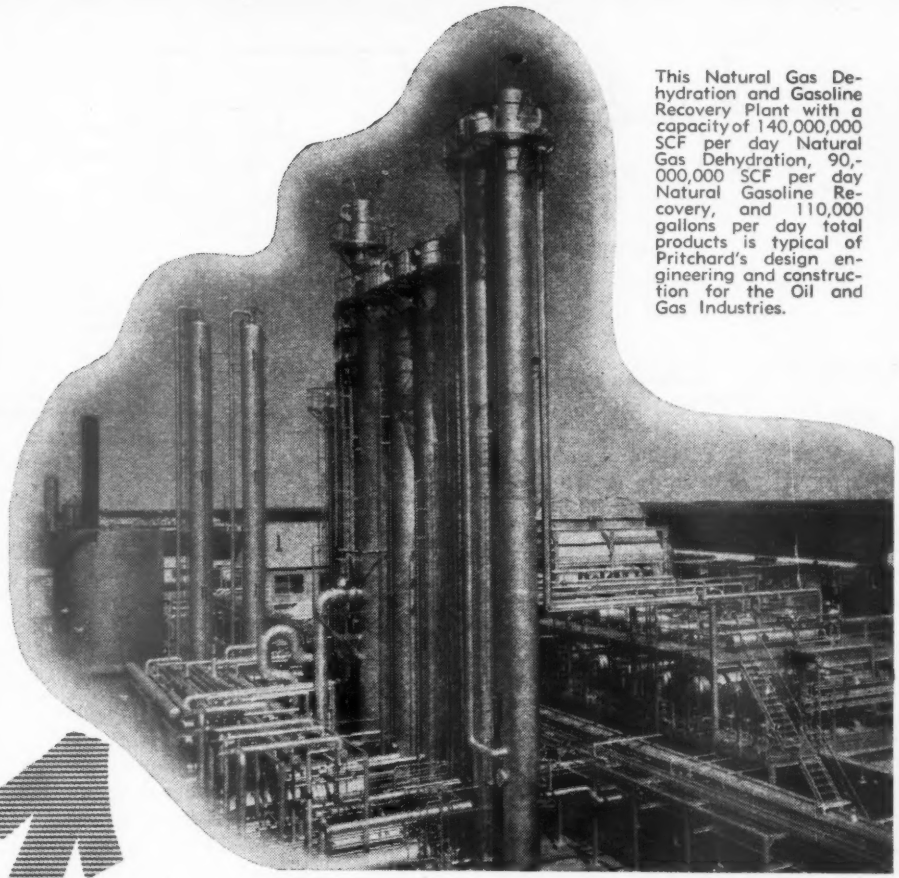

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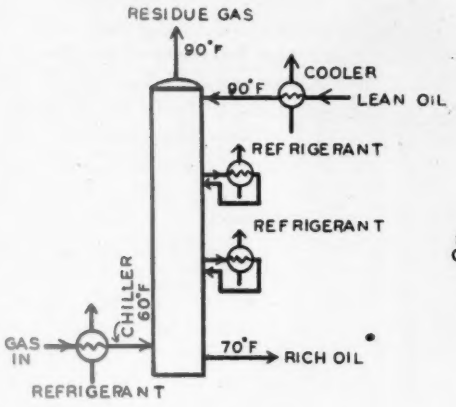


FIG. 6—ABSORBER WITH SIDE CHILLING

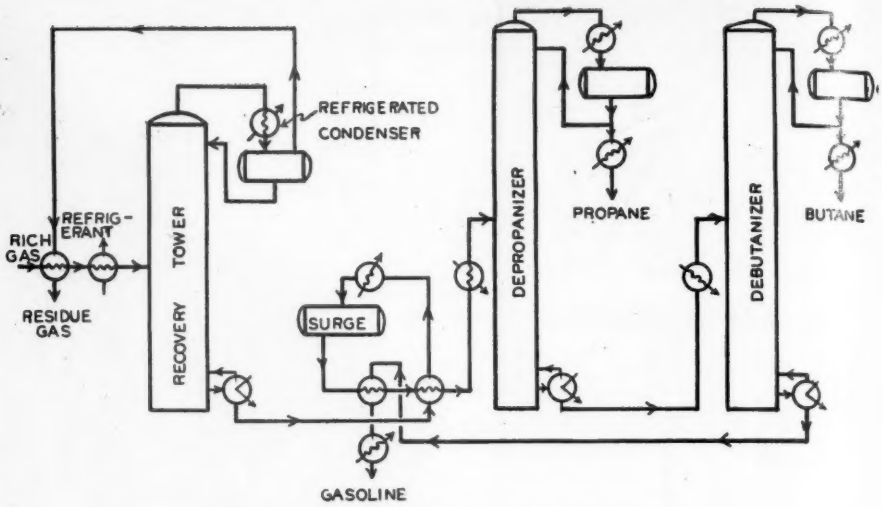


FIG. 7—VAPOR RECTIFICATION SYSTEM

is withdrawn from the absorption-distillation system, circulated through the fractionator reboilers, dehydrator regenerator, etc., and then returned to the main absorption oil stream for final heat exchange and cooling. This is true of the Barnsdall plant described above. The Garvin County plant's central Maysville installation, however, makes use of an independent hot oil system completely divorced from the absorption oil distillation system. Heating oil is circulated through two vertical tube furnaces and delivered, at 500 F, to fractionator reboilers, dehydrator reactivator, and the rich oil demethanizer reboilers. Other furnaces preheat the rich oil to the absorption oil stills.

An alternative to either steam or hot oil heating is the use of Dowtherm. Dowtherm is a high-boiling chemical that vaporizes at much higher temperatures than does water at a given pressure. Unlike hot oil, Dowtherm is capable of giving up its energy as latent heat of vaporization so that less need be circulated and the maximum temperature in the heating system need not be as high as when hot oil is used. At the Carthage Corporation plant a battery of four "heavy" product fractionators separate distillate into gasoline, naphtha, kerosine, and mineral seal oil with reboilers operating at various temperatures between 450 F and 600 F. Two vaporizers supply Dowtherm "A" vapor at 650 F. It is claimed that process control with this system is excellent and that Dowtherm losses have been slight (an important point, as it is a relatively expensive material.

Absorption Oil Refrigeration. A simplified absorption-distillation flow diagram of the Dubach plant of Southwest Gas Producing Company, Inc. and W. C. Feazel is shown in Fig. 4. It is presented here as an example of a well worked out process for high propane recovery. It is necessarily a great deal more complicated than the low recovery plant shown in Fig. 1. Note that rich oil from the high pressure absorbers is pressure-flashed twice, at 425 and again at 200 psig, and then is heated by exchange with hot lean oil and flashed again. Hot flashing the oil in this way produces about the same effect as would a third pressure flash but, as the pressure of the hot flash is still fairly high (175 psig), it is not necessary to recompress the flashed vapors to the reabsorber or pump the rich oil to the high pressure still.

This plant has a two stage absorption oil distillation system similar to that in Fig. 3, previously discussed.

What is unique about this plant is the use of a very light oil in conjunction with refrigeration. Normal gasoline plant absorption oil runs in the order of 180 to 220 mol weight. Published information on the Dubach plant indicates the use of a 155 mol weight, 49 API oil. A given volume of such an oil contains about 10 per cent more mols than does a 180 mol weight, 40-deg A.P.I. oil, which may be considered an average absorption oil. Consequently, all other things being equal, about 10 per cent less oil circulation will be required when using such an oil. There would be a large loss of such a light oil into the residue gas at normal absorber top temperatures (say 100 F); therefore, at the Dubach plant absorption oil is chilled prior to entering the top of the absorber, and the top tray runs at a much lower temperature than usual. This makes the use of such a light oil feasible but there is one disadvantage: the absorber residue gas leaves at a low temperature, a situation normally avoided by chilling the oil several trays down from the top (Fig. 6) rather than at the top. This low temperature represents a substantial loss of refrigeration that must be weighed against the advantages in using the light oil.

Refrigeration Processes

The Dubach plant process is primarily an oil absorption process. Its refrigeration system acts to improve the absorption efficiency of the lean oil stream, but does not in itself act as the primary means of liquid products condensation. There are two general types of processes in which refrigeration does act in this way, however. They are known by a variety of names, of which the most common are "vapor rectification" for one and "refrigeration-compression" for the other. Plants of this type are far outnumbered by oil absorption installations, but under certain circumstances one or the other may be preferable to absorption.

Vapor Rectification. Fig. 7 shows a simplified process flow diagram of a vapor rectification plant. After dehydration (not shown) the rich gas is chilled and introduced to a "recovery tower", a fractionating column generally containing about 30 trays. The column is reboiled at the bottom and refrigerated reflux is pumped into the top. The "rich" gas is usually fractionated between propane and ethane, thus the bottom stream consists of the entire plant production and need only to be fractionated for separation into specification products.

Note that, as the residue gas leaves at its hydrocarbon dewpoint, plant production depends not only on the amount of refrigeration applied but also on the depth of refrigeration. Thus, when feeding a gas of a given

composition and condition to a certain tray in the tower, any increase in propane recovery generally requires a drop in reflux temperature. By raising the feed point and thus allowing a small amount of butanes and heavier to escape overhead, however, increased propane recovery may be obtained without a decreased reflux temperature. (A small amount of heavy ends will replace a large amount of propane in the residue at a given dewpoint temperature.)

Refrigeration-Compression. By allowing some heavy ends to remain in the residue, more propane may be recovered at a given temperature. This principle is carried to the limit in the refrigeration-compression process, of which Magnolia's Sabine, Kansas plant (Fig. 8) is an example. This plant has recently been changed to this process as part of its program to expand the propane recovery from 40 per cent to 70 per cent. As shown, the incoming gas is compressed, dehydrated, and chilled by exchange with cold residue gas and by refrigeration. The resulting condensed liquids are then de-ethanized and fractionated into specification products. Note that this system requires the same number of towers as does the vapor rectification system. As the deethanizer handles only the condensed liquids, however, it need not be as large in diameter as an equivalent recovery tower handling all the wet gas throughput.

As the production is condensed in a single equilibrium step, there must necessarily be some of every component in the residue gas. Under certain conditions such losses into the residue may be very small. For instance, a material balance prepared by Magnolia shows recoveries at the Sabine plant of better than 98 per cent of the pentanes and better than 99 per cent of the hexanes and heavier. These recoveries are comparable to those of the best absorption processes.

As, with either this process or the vapor rectification process, residue leaves at its dewpoint, recovery rates and refrigeration temperatures needed are sensitive to the composition of the incoming gas and the operating pressure. Thus, it is likely to be impractical to use either process at low pressure and/or to handle very lean gas. In either case refrigeration temperatures are likely to be so low as to require prohibitively expensive refrigeration systems. Where the gas is rich and a fairly high pressure is available excellent results can be obtained at moderate depths of refrigeration. At the Sabine plant, for instance, better than 72 per cent propane recovery is claimed when chilling the gas and condensing at 13 F and 250 psig. The gas composition in this case is exceptional, however; it contains 13.5 gpm of propane and heavier.

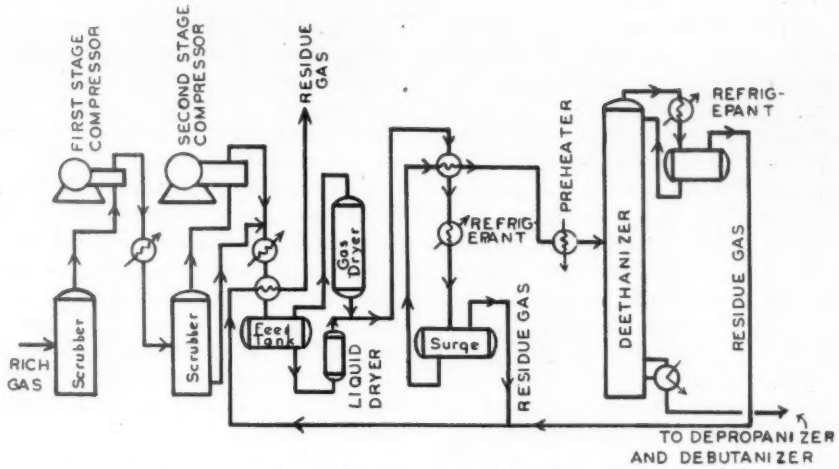


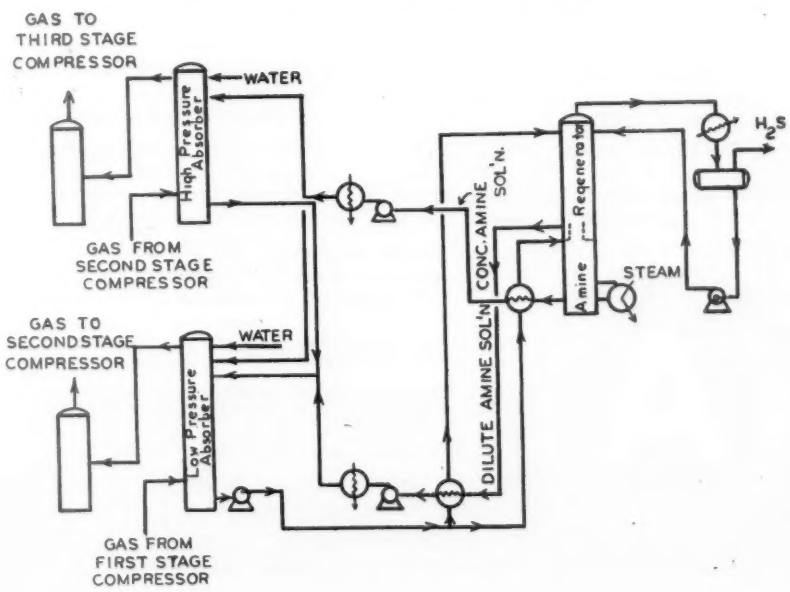
FIG. 8—REFRIGERATION—COMPRESSION SYSTEM

Auxiliary Systems

In addition to the main processes for the recovery of liquid products, gasoline plants contain various auxiliary systems depending on the product specifications, ambient conditions, etc. These include sulfide and mercaptan treating, dehydration, and refrigeration. Gasoline plant refrigeration problems are similar to those encountered in other fields and so will not be considered here.

Treating. Stanolind's Elk Basin plant presents an interesting solution to some severe treating problems. The gas being processed is extremely sour, containing 18.5 per cent hydrogen sulfide along with 2 per cent nitrogen and 6 per cent carbon dioxide. The CO_2 and H_2S are removed from the gas in a "split flow" system by contacting the gas with amine solution (Fig. 9). Rich sour gas is compressed through three stages from slightly above atmospheric pressure to about 500 psig. The "split flow" feature arises from the fact that there are two absorbers, one between the first and second stages and the other between the second and third stages. In the first the gas is treated with partially stripped amine solution, and in the second it is contacted with completely regenerated solution. Most of the H_2S is removed in the first absorber, leaving only a small amount to be taken out in the second. The "split flow" arrangement makes unnecessary the complete stripping of the entire amine solution stream. Thus, the partially stripped solution is withdrawn from

FIG. 9—SPLIT-FLOW AMINE SYSTEM



the middle of the reactivator column and the completely stripped solution from the base. For smaller plants it would probably be simpler and more economical to use a single amine stream with a single absorber.

In addition to treating the gas for the removal of H_2S, the sulfide rich stream is used to produce 74 long tons of elemental sulfur per day. This is done by processing the gas off the amine reactivator in a modified Claus process.

Other treating at this plant includes a caustic wash and contact with a solid dessicant bed for the removal of traces of sulfide and water from the propane product. Another caustic wash is used to remove sulfide from the mixture of butane-gasoline, and the final gasoline is treated in a copper sweetening process.

Dehydration. Removal of water from plant gas is done for one of two reasons. First, if a refrigeration process is to be used, the water content must be reduced in order to prevent formation of hydrates in the chillers. Second, if the residue gas is to be sold to a transmission line it is usually necessary to meet a low water content specification.

Both liquid and solid dessicants are in general use. The liquid system has the advantage of operating on a continuous cycle: The gas is contacted in an absorber containing a few trays and the diluted dessicant is regenerated in a small concentrator. The solid dessicant systems operate on a batch type process, wherein two or more contactors alternately dehydrate the gas and are then regenerated by the application of hot gas or superheated steam. In the smallest installations the liquid system seems to have an advantage, as it will operate with very little expense for labor without the necessity of putting in a complicated system of controls. In the larger systems the cycle controllers used to make the solid bed units automatic become a very small part of the investment, so that the two systems have little to differentiate them on an economic basis. The choice between the solid and liquid systems, therefore, often is decided on the basis of the amount of dewpoint depression needed.

In plants using refrigeration processes subjecting the gas to very low temperatures, solid bed dessicants are generally used. It is possible thereby to obtain dewpoints of –40 F and even lower. The liquid dessicants now in general use, usually one of the glycols, are not capable of reaching such low temperatures. The chief difficulty lies in reconcentrating the glycol to a high concentration without decomposition. In some installations this problem is met by reconcentrating under a vacuum. This is done in the Slaughter plant, where diethylene glycol is concentrated to 97-98 per cent at 8-9 psia.

The Carthage Corporation plant makes use of a new liquid dessicant, the nature of which has not been disclosed. It is claimed that this new dessicant is capable of obtaining a much greater dewpoint depression than is possible with glycol. The installation was designed to dehydrate 110 F gas to a water content of 7 lb per MMCF. Actual performance has resulted in a gas containing only 4 lb per MMCF. This corresponds to a dewpoint depression of about 90 F, which is extremely high for a liquid dessicant.

Normally the gas transmission lines require dewpoints in the neighorhood of 30 F. With glycol dehydrators this corresponds to a maximum allowable gas temperature of about 80 F. Recent developments may allow slightly higher temperatures, and where these temperatures can be obtained, either through throttling effects in the gas or by outside cooling, the glycol units are applicable. Otherwise it is necessary to use the solid dessicants. * *

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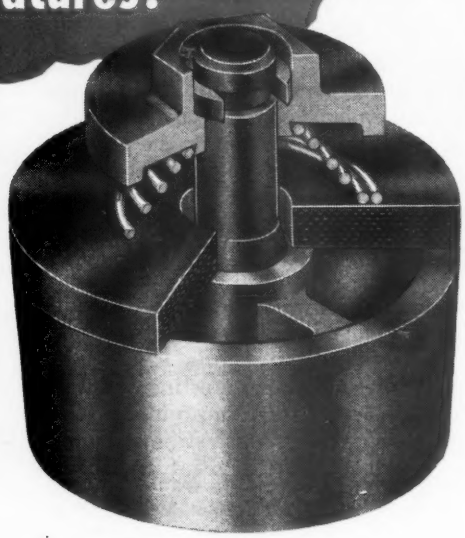

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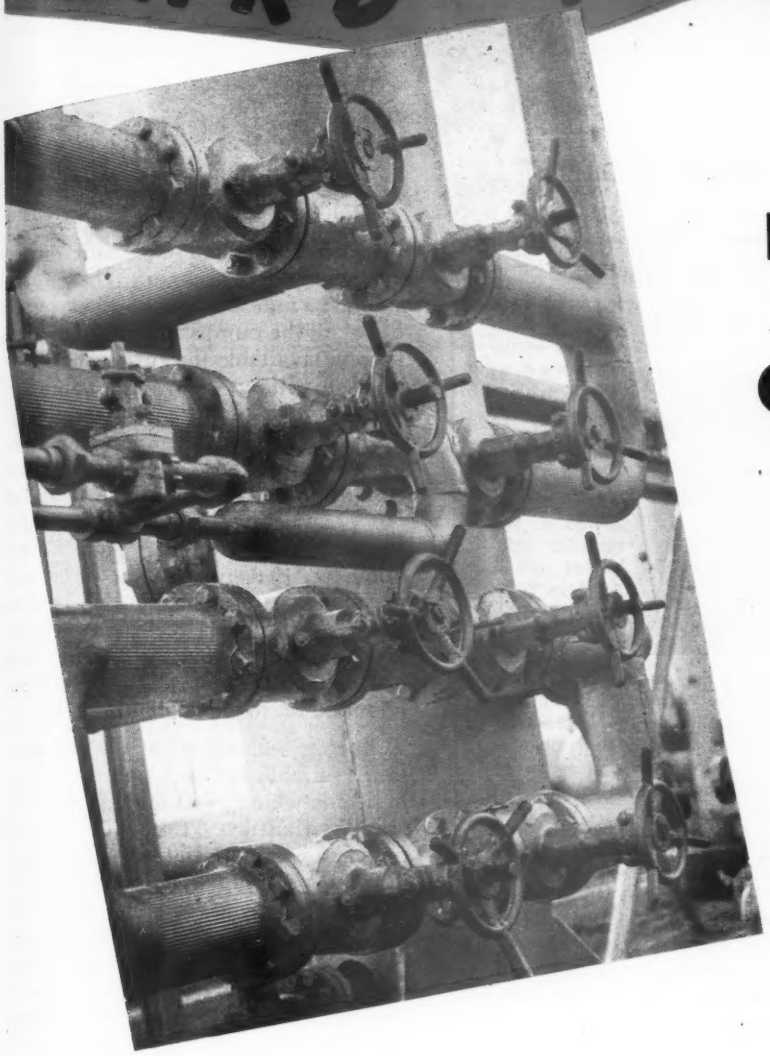

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Standardization of Refinery Pump Parts

WALTER H. GILBERT

REFINERY pumps require constant maintenance; breakdown of a single pump may mean the shutdown of an entire unit with the accompanying loss in production.

With delivery of spare parts ranging from six weeks to six months it has been necessary to keep on hand a complete set of wearing parts for each pump. This method involves the tying up of large amounts of capital in spare parts. This article deals with a method of standardizing parts so as to cover the maximum number of pumps while at the same time keeping the stock of spare parts at a minimum.

Different model pumps of a given manufacturer have certain parts in common. Each part of a pump is identified by the manufacturer's pattern number and material specification. Pattern number should not be confused with part number that some manufacturers have for a particular part and that may be contained within the pattern number. Parts bearing the same pattern number and material specification are identical, and parts having the same part number may or may not be. Our problem is to find the pattern number and material specification of each part and to compile this and other pertinent data in such a manner as to set up a system in which each pump will be listed in terms of the replacement numbers of its parts; and these parts will be correspondingly arranged in the store room.

As there are many pumps of different manufacturers in the refinery it is best to split our work into phases beginning with the make and type of pump most numerous. The system developed for one type of pump can be applied to the other types, whether reciprocating, rotary or centrifugal. In this case the latter was chosen because it was found to be most popular.

Having chosen the type and make of pump most prominent in the refinery our next step is to make a survey of the refinery and its associated departments with a view of getting the number, location and importance of the pumps chosen and the liquid handled by each. This may involve some tiring leg work unless an explicit record has been kept in the refinery office. The next step is to list the pumps of the type chosen and procure all the information available for each pump. This consists of a parts list and a drawing of the model, and a record of the parts contained in each pump giving quantity, part time, pattern number and material specification, and henceforth to be referred to as parts record. If this information is not in the company files it must be obtained from the manufacturer before the standardization procedure can progress much farther. Any maintenance records will aid greatly in the work.

During this standardization a great deal of material will be collected. This material should be filed in a systematic manner, so it will be easy to find. It is best to put the material pertaining to each pump in a separate folder and put the name, serial number and code number on the folder. This file properly arranged will be of great value to the engineer even long after the standardization is completed. An efficiency curve of the pump may be included in the folder, and any electrical data.

A pump record form similar to the one illustrated should be made out for each pump in the refinery. These forms should be indexed so as to give a handy file of all the pumps. As the pump data become available the forms should be filled in without delay. The name and code number of the pump should appear on the form in addition to the other information requested. The rated conditions may be obtained from the pump nameplate or from the manufacturer. The impeller pattern and diameter, the stuffing box data, and the pump materials should all be contained in the parts record. It is especially important that the bearing data be filled in. The data of the driver can be found on its nameplate.

Having secured all of the information available for each pump we have to decide which parts to include in the standardization. For centrifugal pumps it is not advisable to stock such items as parting flange gaskets if they are made of a material that dries out. It is also not practical to stock such parts as pump casings, because if the pump casing wears out it is usually time to get a new pump. Nevertheless, the name of the casing material should be filled in on the pump record form. The parts most subjected to wear are casing rings, impeller rings, and shaft sleeves. Impellers may or may not be stocked but they should be included in the standardization. It is also recommended that such miscellaneous parts as shaft nuts, shaft sleeve nuts, shaft sleeve gaskets, etc., be listed. Bearings may be standardized along with the other parts, or since they may be common to more than one make of pump the entire bearing standardization may be handled as a separate process as described later on.

Before starting on the actual work we may be wise to set up a code so that each pump in the refinery may be identified by a combination of letters and numbers. It is suggested that the first symbol in the code identify that unit or department the pump is in, the second part be the rated horsepower of the driver, the third part be a symbol for the service or liquid pumped, the fourth part an indication of the pump manufacturer, and the last part

The Author

Walter H. Gilbert went to work for Socony Vacuum Oil Company at its East River, New York refinery in the summer of 1948 where he worked on the standardization of refinery pump parts. He received his first technical education at the Brooklyn Technical High School. After serving in the Army during the war he continued his studies at the Polytechnic Institute of Brooklyn for the degree of Bachelor of Mechanical Engineering. He is now working on new ways and means of saving on process steam in wax and oil refining.

EXCLUSIVE

FIG. 1

Pump Record

Serial No.	Size & Type	Pump Manufacturer	Mfr. Order No. Item No. Cust. Order No.	Date Shipped

RATED CONDITIONS	STUFFING-BOX DATA	PUMP MATERIALS
Gpm	Box dia.	Casing
Discharge pressure	Shaft or sleeve dia.	Casing rings
Total head, ft.	No. of rings { suct.	Impeller
Suction, + or – ft.	{ h-press.	Impeller rings
Rpm	Packing size	Shaft
Liquid	Packing mfr.	Shaft sleeves
Temp, °F.		Radial brg. { type
Viscosity	Packing No.	{ size
Sp. Gr.		Thrust brg. { type
Impeller pattern		{ size
Impeller dia.		Gasket thickness
Rotation (from outboard end)		Wearing ring clearance

Driver	Mfr	Serial No.	Type
Hp	Rpm	Frame	Enclosure
Volts	Phase	Cycles	
Inlet steam, psi gage	Total Temp °F.	Exhaust, psi gage	
Control: type	Mfr.		

Maintenance Record

INSPECTION & REPAIRS					
Date	Condition	Due to	Repaired by	Cost	Remarks

Compliments of Ingersoll-Rand Company, Cameron Pump Division, New York, N. Y.

Form 7049

a letter or number to differentiate between pumps whose code designation would otherwise be the same. For example:

S D, steam department;
25, 25 hp,
B F, boiler feed;
I R, Ingersoll Rand.

Having assembled all our data, we are ready to start compiling them. The first step is to draw up a work sheet as illustrated, listing the pump size, serial number and code number, and providing columns for the various parts to be standardized.

Using the parts record for each pump we fill in the pattern number, material specification, and quantity of each part contained in the pump. For impellers, the diameter should be listed in addition to all the other information. On previous overhauls of the pump, modifications may have been undertaken and a new copy of the parts record made. The quantity of a given part required should be checked against the quantity given in the parts list for the model. If a part is not listed on the parts record and yet the parts list shows that the pump contains such a part, this discrepancy should be noted and inquiry made of the manufacturer. The first work sheet will then give the specifications of all parts contained in each pump.

When all necessary information has been filled in on the first work sheet we may start the second work sheet. These sheets shall list the information contained on the first work sheet in a

FIG. 2. First work sheet—Part 1. Standardization of refinery pump parts.

Size	Serial No.	Impeller rings	Casing rings	Shaft sleeve	Shaft	Water seal cage	Gland two-halves	Oil ring	Intermediate sleeve	Channel ring	Stuffing box bushings: inboard	Stuffing box bushings: outboard	Shaft nut	Shaft sleeve nut	Shaft sleeve gasket
1CRV	04396488														
1MRV	05396185														
1MRVN5	09455712														
1RV3	120278														
1½FL	063824														
1½FL	063825														
1½FL	09423368														
1½FL	09423371														
1½TRVH12	09428228														
1½RVH7½	05425045														
1½RVH1½	0838711														
1½RVH1½	117494														
1½RVH1½	117521														
1½RVH1½	117522														
1½RVH3	118131														
1½RVN5	08456315														
2AGT	09423294														
2AGT	09423295														
2CRV	106844														
2CRV	107152														
2CRVH	112495														
2FL	063889														
2FL	063890														
2FL	0940138														
2GT2	073816														
2GT2	073823														
2GT2	0938105														
2GT2	0938107														
2JVL	84027														
2RV7½	05397918														
2RV1	0538877														
2RV1	0538878														
2RV1	0538879														
2RVH	05401185														
2RVH10	0638536														
2RVH10	0638686														
2RVH10J	0838718														
2RVH15	0838662														
2½NT4	073862														
2½NT4	073870														
2½UV2	79215														

FIG. 2. First work sheet—Part 2. Standardization of refinery pump parts.

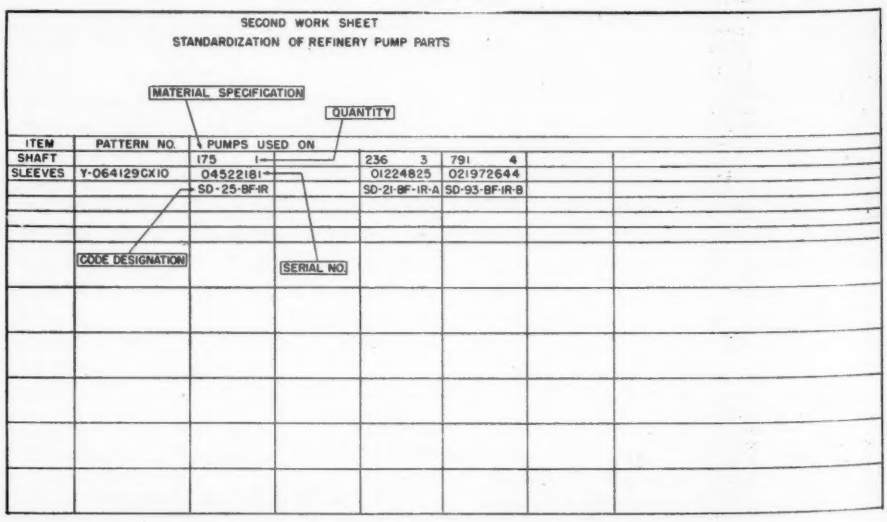
Size	Serial No.	Journal sleeve	Flinger	Bearing housing	Bearing end cover	Parting flange gasket	Casing (compl.)	Bearing manufacturer's number		Lock nuts		Lockwashers		Channel ring bushing
								inboard	outboard	radial	thrust	radial	thrust	
1CRV	0439648S							SKF6407M	SKF1307M					
1MRV5	0539618S							SKF7307BDY	SKF6306M					
1MRVN5	09455712													
1RV3	120278													
1½FL	063824							SKF7407BDY	SKF5408M					
1½FL	063825							SKF7407BDY	SKF5408M					
1½FL	09423368							SKF7407D	SKF5408					
1½FL	09423371							SKF7407D	SKF5408					
1½TRVH12	09428228							SKF7307D	SKF1306					
1½RVH7½	05425045							SKF7307B	SKF6307					
1½RVH1½	0838711													
1½RVH1½	117494													
1½RVH1½	117521													
1½RVH1½	117522													
1½RVH3	118131													
1½RVN5	08456315													
2AGT	09423294							SKF1308	SKF7406-D					
2AGT	09423295							SKF1308	SKF7406-D					
2CRV	106844							SKF1307	SKF6407					
2CRV	107152							SKF1307	SKF6407					
2CRVH	112495							SKF6407M	SKF1307M					
2FL	063889							SKF7407BDY	SKF5408M					
2FL	063890							SKF7407BDY	SKF5408M					
2FL	0940138							SKF7407BDY	SKF5408M					
2GT2	073816							SKF1206M	SKF7305BDY					
2GT2	073823							SKF1206M	SKF7305BDY					
2GT2	0938105							SKF1206M	SKF7305BDY					
2GT2	0938107							SKF1206M	SKF7305BDY					
2JVL	84027							SKF1308M	SKF7406BDY					
2RV7½	0539791S							SKF6307BDY	SKF6307M					
2RV1	0538877							SKF6307M	SKF6305M					
2RV1	0538878							SKF6307M	SKF6305M					
2RV1	0538879							SKF6307M	SKF6305M					
2RVH	05401185													
2RVH10	0638536							SKF7309BDY	SKF6309M					
2RVH10	0638686							SKF7309BDY	SKF6309M					
2RVH10	0838718							SKF7309BDY	SKF6309M					
2RVH15	0838662													
2½NT4	073862							SKF1308	SKF7406D					
2½NT4	073870							SKF1308	SKF7406D					
2½UV2	79215							SKF1304	SKF7304D					

manner useful to our purpose. It is best to use a separate sheet for each part and write the name of the part on the top left hand side of the sheet. The first column of this sheet is to contain the different pattern numbers of the part. Each pattern number should be put on the middle line of a three line space. The rest of the space to the right of the pattern number is to be used to list the serial number and code number of each pump having that part and the quantity and material specification as shown in the illustration.

The sheet is filled in by picking off the first work sheet the first pattern number under the particular part. This pattern number is put in the first space; and in the second space to the right, is put the serial number and code number of the pump in which the part is used, the material specification, and quantity required. If, for instance, the first pattern number appearing under shaft sleeve is Y-087558CX10 then this number is put in the middle of the first space; and if the serial number of the pump having that part is 04596485, the code number SD-5-W-IR, the material specification 2OK and the quantity one, then this information is put on the first space to the right of the pattern number. Each time this same pattern number is found, the serial number, code number, material specification, and quantity are put in the next right hand space on the second work sheet. For impellers the diameter is also indicated. When all the pumps listed have been gone over, the next pattern number is picked off the first work sheet and the process is repeated until all the pattern numbers have been listed. The second work sheet should then show at a glance how many pumps a shaft sleeve of a given pattern number will fit. The same type sheet is made for all parts to be standardized. Thus there will be a second work sheet for casing rings, impeller rings, shafts, impellers, etc.

It should be noted that all the pumps listed after a given pattern number on the second work sheet contain the same parts except perhaps for material. Thus it is necessary to decide which material to use, in standardizing the part. The material presently employed in the pump is governed by the liquid handled and the cost. In standardizing it may be possible to use one or possibly two materials to cover all pumps which have identical parts in common. At this time it would be a good idea to decide tentatively how many pieces of particular pattern number should be stocked. This is dependent upon the number of pumps having that part and the importance of the service in which they are engaged. Very little help can be given the engineer on this point and he will have to rely on his own experience and judgment to guide him.

FIG. 3



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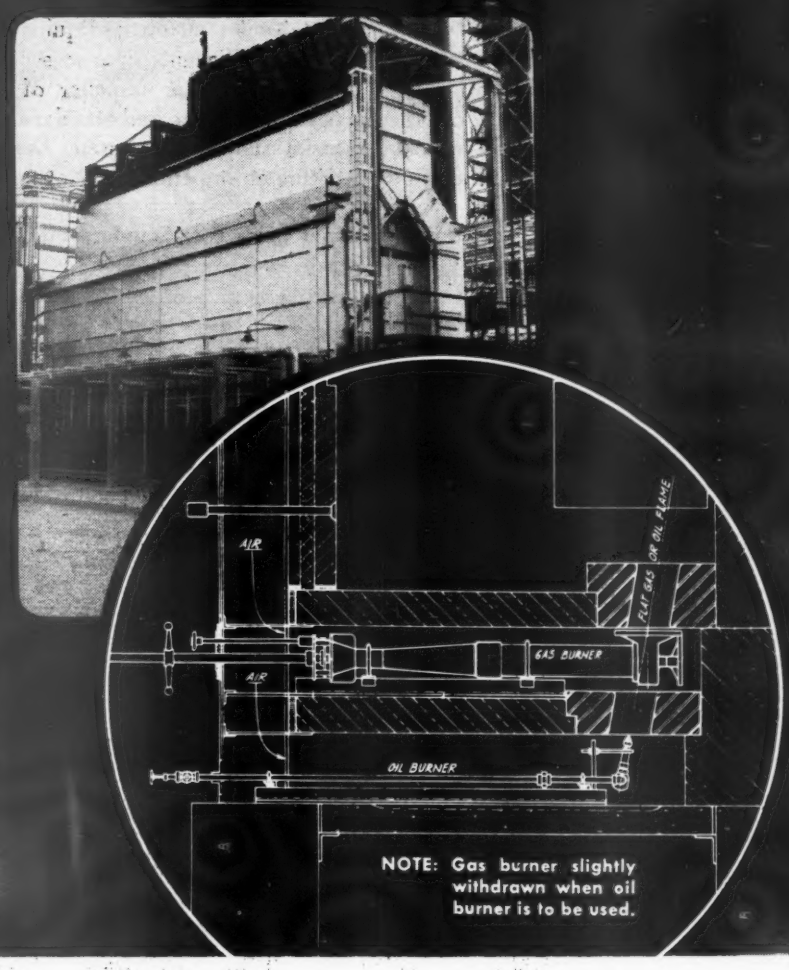


NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: 1259 EAST SEDGLEY AVENUE
PHILADELPHIA 34, PA.

SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD
HOUSTON 6, TEXAS

FIG. 4

THIRD WORK SHEET
STANDARDIZATION OF REFINERY PUMP PARTS

UNIT & PUMP	SERIAL NO.	CODE DESIG.	IMP L RING	CASING RING	SHAFT SLEEVE	SHAFT	IMPELLER	SHAFT SLEEVE NUT	SHAFT SLEEVE GASKET	SHAFT NUT LOCKWASHER	REMARKS
A-UNIT											
GASOLINE											
CHARGE	0217249	A-1-GR-IR	IR-1	CR-1	SS-1,SS-1	S-1	1-1 4D	SSN-1	SSG-2	SN-1	
B-UNIT											
GASOLINE											
CHARGE	0521342	B-1-GR-IR	IR-1	CR-1	SS-1,SS-1	S-1	1-1 4D	SSN-1	SSG-2	SN-1	
C-UNIT											
SOLVENT											
CHARGE	0332152	C-1-GR-IR	IR-5	CR-3	SS-3,SS-3	S-6	1-3 5D	SSN-5	SSG-3	SN-8	

When the number of each pattern number to be stocked has been determined, we can better decide on the material. If, for example, there is one shaft sleeve that will fit 12 pumps and it has been decided to stock only one, then the sleeve of the best material that could operate in all or most of the pumps should be chosen. If on the other hand it has been decided to stock four shaft sleeves that will fit the same 12 pumps, then two of each material may be stocked.

In standardizing impellers the problem is twofold: First, the impellers must be standardized to a material suitable for all of the liquids handled by the different pumps; second, the largest diameter impeller of a given pattern number and standardized material should be chosen. For pumps taking an impeller of the same pattern number but smaller diameter, the larger diameter impeller may be turned down to size. To illustrate: Suppose on our second work sheet for impellers we have 12 impellers of different diameters listed after a given pattern number X3RVS3AX1. After considering the liquids pumped we decide to stock one bronze impeller to cover 8 of the 12 pumps, and one stainless steel impeller to cover the other four. Now if the eight pumps covered by the bronze impeller have impeller diameters ranging from 4⅞ in. to 5½ in., we have to choose the 5½ in. impeller as the one to be stocked. If the four pumps covered by the stainless steel impeller have impellers ranging in diameter from 6⅝ in. to 5¼ in. then a 6⅝ in. stainless steel impeller of the given pattern number should be ordered.

The engineer may want to go over the standardization of materials with the representative of the manufacturer of the pumps being standardized. The manufacturer will usually be happy to send one of his sales engineers to help in this and other phases of the standardization. If the pump manufacturer uses a code to designate his materials, a code list identifying the materials will have to be obtained from him.

FIG. 5 Final parts list. Standardization of pump parts.

							Information necessary for re-ordering parts				
Name of part	Tag No.	Fluid	Pump size	Serial No.	Pattern No.	Identifying code	Min. No. of parts to be kept in stock	Part No.	Material	Pump size	Serial No.
Shaft Sleeve	SS-1	Fresh water	1CRV	04396488	Y-0875S8CX10	GP-5-W-IR	2	8	20K	2RVH	0638686
		P. C. soda	1½RVH	117494	Y-0875S8CX10	OT-1½-S-IR					
		Kerosine!	1½RVH	117521	Y-0875S8CX10	OT-1½WWS-IR					
		Sod. sulfide	1½RVH	117522	Y-0875S8CX10	OT-1½-SS-IR					
		Lt. naphtha	1½RVH	118131	Y-0875S8CX10	C-3-N-IR					
		Regen. soda	2CRVH	112495	Y-0875S8CX10	GP-15-S-IR					
		Gasol. prod.	2RVH	0638536	Y-0875S8CX10	8-10-G-IR-B					
		Gasol. prod.	2RVH	0638686	Y-0875S8CX10	8-10-G-IR-A					
	SS-2	No. 3 fuel oil	3RVS	118171	Y-0875S8CX10	CY-10-FO-IR	4		25I	3RVS	118171
		Soda	1 MRV	05396185	Y-0875S8CX10	GP-5-S-IR					
		N. D. soda	1½RVH	0838711	Y-0875S8CX10	OT-1½NDS-IR					
		Soda	2RV	05397918	Y-0875S8CX10	GP-7½-S-IR					
		Gasol. ref.	2RVH	0838718	Y-0875S8CX10	A-10-GR-IR					
		Deb. B't'ms	2RVH	0838662	Y-0875S8CX10	OT-15-N-IR					
		Lt. naphtha	3RVS	0838712	Y-0875S8CX10	OT-7½LN-IR					
		Crude oil	3RVS	0838762	Y-0875S8CX10	CY-7½-CO-IRA					
		Crude oil	3RVS	0838763	Y-0875S8CX10	CY-7½-CO-IRB					
		Naph. dist.	3RVS	117628	Y-0875S8CX10	OT-7½-N-IR					
		Naphtha	3RVS	117493	Y-0875S8CX10	LYP-10-I-IR					
		Solar red	3RVS	118170	Y-0875S8CX10	CY-10-SR-IR					
	SS-3	Fresh water	1MRVN	09455712	Y-0875S8CX10	7-5-FW-IR	2	8	162	1MRVN	09455712
		Salt water	2CRV	107152	Y-0875S8CX10	S-S-5-SW-IR					
	SS-4	Salt water	1½RVN	08456315	Y-0875S8BX1	8-5-SW-IR	1	8	162	1½RVN	08456315
	SS-5	Vent oil	1½TRVH	09428228	Y-0875S8CX1	8-6.5-VO-IR	1	8	20K	1½TRVH	09428228
		Vent oil	1½RVH	05425045	Y-0875S8CX1	8-7½-VO-IR					
		Naphtha	2RVH	05401185	Y-0875S8CX1	5-7½-N-IR					
	SS-6	B. T. B't'ms	3SFL	C40365	Y-175S8ADX1	5-24-HO-IR	2	8	113N	3SFL	C40365
		T. T. Reflux	3SFL	C40359	Y-175S8ADX1	5-10-HO-IR					
		Quench	2FL	0940138	Y-175S8ADX1	8-10-Q-IR					
	SS-7	Naphtha prod.	1½FL	063824	Y-175S8ADX1	8-3-N-IR-A	2	8	20K	1½FL	063824
		Naphtha prod.	1½FL	063825	Y-175S8ADX1	8-3-N-IR-B					
		T. S. Reflux	1½FL	09423368	Y-175S8ADX1	8-7-R-IR					
		T. S. Reflux	1½FL	09423371	Y-175S8ADX1	8-10-R-IR					
		Fract. B't'm	2FL	063889	Y-175S8ADX1	8-5-FB-IR-A					
		Fract. B't'm	2FL	063890	Y-175S8ADX1	8-5-FB-IR-B					
		Dist. fuel oil	3FL	0538148	Y-175S8ADX1	8-10-FOD-IR-A					
		Dist. fuel oil	3FL	0538146	Y-175S8ADX1	8-10-FOD-IR-B					
	SS-8	Tar	2AGT	09423294	Z-2AGT57AX1	8-60-HO-IR	1	57	20K	2AGT	09423294
		Tar	2AGT	09423295	Z-2AGT57AX1	8-48.7-HO-IR					
	SS-9	Tar	2AGT	09423294	Y-162S8FX1	8-60-HO-IR	2	8	378N	2AGT	09423294
		Tar	2AGT	09423295	Y-162S8FX1	8-48.7-HO-IR					
	SS-10	B. T. Reflux	2JVL	84027	Y-162S8AX9	7-40-R-IR		8	113N	2JVL	84027
	SS-11	Salt water	8LFV	09423384	Y-162S8AX9	8-30-SW-IR		8	162	8LFV	09423384
		Salt water	8LFV	A423046	Y-162S8AX9	8-28-SW-IR					

Interior view of Tulsa, Oklahoma, warehouse of Worthington.

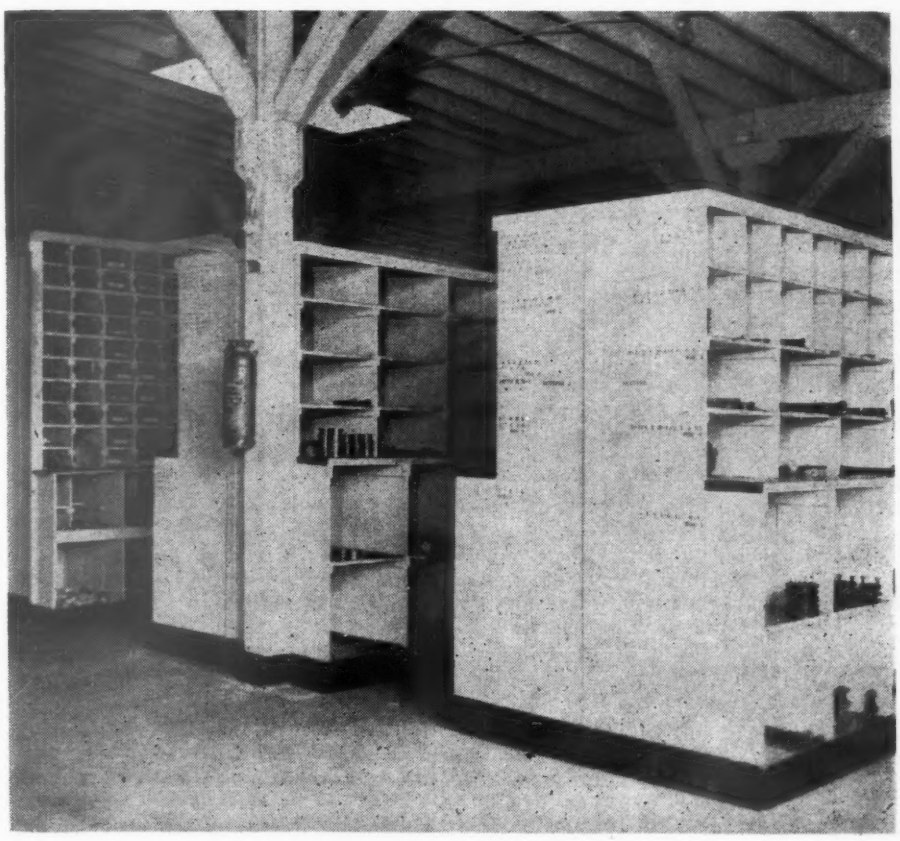
Once the materials have been standardized and the quantities of each part to be stocked determined, the next thing is to prepare a parts order to send to the manufacturer for an estimate. The parts order has to contain the following information for each part ordered: Pattern number, quantity wanted, material specification, part number, model, and serial number of the pump that was fitted with that part by the manufacturer. For our own record this may be followed by listing the code number of all the pumps that will take that part.

In order to check our work to date and set up a permanent system we list by unit, on a third work sheet, the pumps involved in this phase of our standardization. As in every-day refinery procedure the pumps are identified by name and not by serial number, they should be so listed in order to facilitate establishment of the new system. Next to the name should be the code and serial numbers. There should be one vertical column for each part. The sheet should tell whether or not the part is contained in the pump and if so, whether or not the part is stocked. This can be done in the following manner: If, for instance, the pump has a shaft sleeve and the shaft sleeve is stocked, the stock number of that shaft sleeve can be put in. For that purpose each part must have a stock number. This number can be assigned arbitrarily to each part listed in the parts order, and should consist of an abbreviation for the name of the part followed by a number. For instance, the first pattern number listed under shaft sleeves in the part order would be SS-1, the next SS-2, and so on; the first pattern number listed under casing rings would receive the stock number CR-1, etc. If the part is not stocked, this can be indicated by the letter X. If the pump does not have a part this fact can be indicated by a dash.

Upon completion of this work the project should be presented to all of the departments concerned. This may be done by conferences with one man from each department at a time. These men will find that this standardization makes their daily work easier as well as saving the company money. They may, however, have some valuable suggestions that will aid in completing the rest of the standardization. The system described here is flexible enough to withstand any change that might be found useful in the particular case. Any changes should be made before drawing up the final parts list.

After the system has been approved the permanent parts list should be drawn on tracing cloth so that copies may be made and sent to each depart-

Parts are kept in orderly fashion at A. W. Lockett Company.



ment. It lists the parts by stock number, followed by the pattern number, fluid pumped, pump size, and serial number, minimum number of parts to be kept in stock and all information necessary for reordering. A typical permanent parts list is illustrated. The third work sheet described and illustrated above, should be redrawn on tracing cloth so as to form a part of the permanent record.

When an estimate for the cost of the spare parts stock is received and approved, the parts may be ordered. As the parts are received they should be tagged with the stock numbers before being put on the shelf.

If bearings were not included in the standardization they may be taken care of when all the other phases of the standardization have been completed. A bearing list may be made by listing all of the pumps and picking the bearing information off the pump record form. A second sheet much like the second work sheet of the standardization may then be made, listing each bearing and all the pumps that it will fit. The quantity of each bearing to be stocked may then be determined. Each type and size bearing stocked should be given a stock number and this stock number should be recorded on the bearing list.

As the system is put into use the typical procedure is as follows: If a machinist finds he needs a shaft sleeve, two casing rings, and a shaft sleeve nut for replacement on X-Unit gasoline reflux pump, he looks on the permanent copy of the third sheet under X-Unit gasoline reflux pump. Then under shaft sleeve casing ring and shaft sleeve nut, he looks up the stock numbers of the ones that will fit the pump. Then all he has to do is to requisition the parts from the store room. The stock clerk on the other hand has only to look for the stock number on the tag attached to the part. The storekeeper has to reorder the parts withdrawn as per information given on the store room copy of the permanent parts list. The engineer will note in his record the repairs made. The procedure for replacing a worn bearing is the same as replacing any other standardized part.

The standardization may be completed by applying the process described above to other types of makes of pumps, provided the type and make is numerous enough to warrant the work involved. This system developed for centrifugal pumps will work equally well for rotary or reciprocating pumps.

The successful administration of this system depends upon the upkeep of the records involved. As was mentioned in the beginning of this article, a pump record form similar to the one illustrated should be made out for each pump in the refinery, whether or not this pump is included in any phase of the standardization. Any maintenance or repair work done on the pump should be recorded on this form. In addition, a periodic check should be made to see that the stock of spare parts is kept at the required minimum.

The correct application of the system will in time result in a substantial saving of money. It permits the consolidation of pump maintenance work and thus leaves the operating man free to attend to their part of the production process. It eliminates loss in production due to pump failures. More than that, it gives a clear picture of what each pump is doing and what equipment is available in case of plant modification or change-over. *

FIG. 6. Final parts list. Standardization of pump parts.

								Information necessary for re-ordering parts				
Name of part	Tag No.		Fluid	Pump size	Serial No.	Pattern No.	Identifying code	Min. No. of parts to be kept in stock	Part No.	Material	Pump size	Serial No.
Impeller	I-1	5¼"D	Soda	1MRV	0539618S	X-1MRV3AX1	GP-5-S-IR	1–5¼D	3A	203	1MRV	0539618S
			Fresh water	1MRVN	09455712	X-1MRV3AX1	7-5-FW-IR					
	I-2	5¼"D	Soda	1MRV	0539618S	X-1MRV3Bxb	GP-5-S-IR	1–5¼D	3B	203	1MRV	0539618S
	I-3	4$^{13}/_{16}$"D	Salt water	1½RVN	08456315	X-150RVN3AX2	8-5-SW-IR	1–4$^{13}/_{16}$"D	3	156	1½RVN	08456315
	I-4	7¼"D	W. W. Soda	1½RVH	117521	X-150RVH3AX1	OT-1½WWS-IR		3	203	1½RVH	117521
		7¼"D	Sodium sulf.	1½RVH	117522	X-150RVH3AX1	OT-1½SS-IR					
		7¼"D	Nap. dist. soda	1½RVH	0838711	X-150RVH3AX1	OT-1½NDS-IR					
	I-5	7$^{5}/_{8}$"D	P. C. Soda	1½RVH	117494	X-150RVH3BX1	OT-1½-S-IR			203	1½RVH	117494
		7$^{5}/_{8}$"D	Vent oil	1½TRVH	09428228	X-150RVH3BX1	8-6.5-VO-IR					
		7$^{5}/_{8}$"D	Vent oil	1½RVH	05425045	X-150RVH3BX1	8-7½-VO-IR					
		7$^{7}/_{16}$"D	Lt. naphtha	1½RVH	118131	X-150RVH3BX1	C-3-N-IR					
	I-6	5$^{3}/_{16}$"D	Soda	2RV	0539791S	X-2RV3EX1	GP-7½-S-IR	1–5$^{3}/_{16}$D	3	203	2RV	0539791S
		4$^{5}/_{16}$"D	Salt water	2CRV	107152	X-2RV3EX1	S-5-SW-IR					
	I-6A	4D	Aux. feed	2RV	0538877	X-2RV3EX1	8-1-F-IR		3	203	2RV	0538877
		4D	Aux. feed	2RV	0538878	X-2RV3EX1	8-1-F-IR					
		4D	Aux. feed	2RV	0538879	X-2RV3EX1	8-1-F-IR					
	I-7	4$^{15}/_{16}$"	Nap. dist.	3RVS	117628	X-3RVS3AX1	OT-7½-N-IR	1–5½D	3	203	3RVS	0838762
		4⅞"	Crude oil	3RVS	0838762	X-3RVS3AX1	CY-7-CO-IR-A					
		4⅞"	Crude oil	3RVS	0838763	X-3RVS3AX1	CY-7-CO-IR-B					
		4⅞"	Lt. naphtha	3RVS	0838712	X-3RVS3AX1	OT-7-LN-IR					
		5½"	Naphtha	3RVS	117493	X-3RVS3AX1	LYP-10-I-IR					
		5½"	Solar red	3RVS	118170	X-3RVS3AX1	CY-10-SR-IR					
		5½"	No. 3 fuel oil	3RVS	118171	X-3RVS3AX1	CY-10-FO-IR					
	I-8	7½"	Gasol. refl.	2RVH	0838718	X-2RVH3AX1	A-10-GR-IR	1–7½D	3	203	2RVH	0838718
		5⅞"	Soda	2CRVH	112495	X-2RVH3AX1	GP-15-S-IR					
		7$^{7}/_{16}$"	Naphtha	2RVH	05401185	X-2RVH3AX1	5-7½-N-IR					
		6⅞"	Gasol. prod.	2RVH	0638686	X-2RVH3AX1	8-10-G-IR-A					
		6⅞"	Gasol. prod.	2RVH	0638686	X-2RVH3AX1	8-10-G-IR-B					
	-9	6$^{5}/_{8}$"	Quench	2FL	0940138	X-2FL3BX1	8-10-Q-IR	1–3$^{5}/_{8}$D	3	338	2FL	063889
		5¼"	Fract. B't'ms	2FL	063889	X-2FL3BX1	8-5-FB-IR-A					
		5¼"	Fract. B't'ms	2FL	063890	X-2FL3BX1	8-5-FB-IR-B					
	I-10	7$^{3}/_{16}$"	Fresh water	3CRVH	02465466	X-3RVH3BX1	FW3-30-W-IR	1–7$^{3}/_{16}$D	3	203	3CRVH	02465466
		6⅜"	Fract. refl.	3RVH	0638569	X-3RVH3BX1	8-15-R-IR-A					
		6⅜"	Fract. refl.	3RVH	0638570	X-3RVH3BX1	8-15-R-IR-B					
	I-11	8¼"	T. Str. refl.	1½SFL	02473085	X-150SFL3AX2	8-10-VR-IR		3	100	1½SFL	02473085
		8¼"	T. Str. refl.	1½SFL	02473087	X-150SFL3AX2	8-7.8-VR-IR					
		7½"	Hvy. gas oil	1½SFL	02473326	X-150SFL3AX2	8-10-GO-IR				1½SFL	02473326
		7½"	Hvy. gas oil	1½SFL	02473090	X-150SFL3AX2	8-7.8-GO-IR					
	I-12	4¾"	Aux. feed	2RVL	0538877	X-2RV3EX1	8-1-F-IR		3	203	2RV1	0538877
			Aux. feed	2RVL	0538879	X-2RV3EX1	8-1-F-IR					
			Aux. feed	2RVL	0538879	X-2RV3EX1	8-1-F-IR					
	I-13	5$^{13}/_{32}$"	Lube oil	1½RV	06401070	X-150RVL32X1	G & C-5-Lube-IR		3	203	1½RV	06401070
			Wax	1½RV	07456413	X-150RVL32X1	G & C-5-Wax-IR					
				1½RV	07556414	X-150RVL32X1	G & C-5-Wax-IR					
			Wax	1½RV	07456415	X-150RVL32X1						
			Lube oil	1½RV	07455486	X-150RVL32X1	G & C-5-Lube-IR					
			Wax emul.	1½RV	A466432	X-150RVL32X1	G&C-5-W. Emul. IR					

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Sulfur Reduction in Thermally Cracked Naphtha

W. P. BALLARD and A. R. VANDER PLOEG

Demand for more crude oil forces use of varieties in which sulfur content must be reduced by desulfurizing charge stock or by taking sulfur out of product

THE increase in high sulfur crude running resulting from the depletion of known low sulfur crude oil fields has accentuated the problem of sulfur control in finished products, particularly at those plants receiving only minor proportions of low sulfur crude. High sulfur contents are often objectionable in gasoline since the tetraethyl lead susceptibility is adversely affected by certain sulfur compounds, requiring a greater amount of tetraethyl lead to reach a given octane level. The larger lead requirement resulting from high sulfur contents is becoming an increasingly serious and costly problem.

In order to reach present day competitive octane levels and still keep lead costs at a reasonable figure, refiners have resorted to desulfurization and/or reforming of straight run naphthas to increase lead susceptibility and octane number of finished blended gasoline. In many refineries this is all that is required to keep the overall plant blend of finished gasoline at a reasonable sulfur level; however, where large proportions of the total crude being run are of the high sulfur type, additional sulfur removal would be desirable. This would, of course, involve the desulfurization of cracked naphthas. It is the purpose of this paper to discuss various methods of reducing the sulfur content of thermally cracked naphtha, both from the standpoint of charging stocks to the thermal operation and treating methods for the naphtha produced.

TABLE 1. Variations in naphtha sulfur content with charge stock source.

Crude source of charge stock	California		West Texas		Arabian	
Sulfur content of charge,* wt. %..	1.56	2.57	1.54	2.75	1.77	3.04
Sulfur content of naphtha,‡ wt. %	0.53	0.75	0.31	0.50	0.12	0.18

* Bomb method — ASTM D129-44
‡ Lamp method — ASTM D90-47T

TABLE 2. Effect of thermal cracking operation on sulfur content of product naphtha using charge stock from Arabian crude.

Operation	Charge sulfur	Naphtha sulfur	Naphtha sulfur adjusted to 1.77% charge sulfur
Single-pass gas oil cracking.....	1.77	0.12	0.120
Recycle cracking to fuel.....	3.04	0.18	0.105
Recycle cracking to fuel and pitch	3.04	0.27	0.157
Recycle cracking to coke.....	4.78	0.50	0.185

The source of the charge stock to a thermal cracking operation has a decided influence on the sulfur content of the resultant naphtha at a constant sulfur content for the cracking charge stock. Data demonstrating the effect of charge stock source are shown in Table 1.

At about 1.5-1.7 per cent charge sulfur, the naphtha sulfur varied from 0.12-0.53 per cent, while at 2.6-3.0 per cent charge sulfur the naphtha sulfur varied from 0.18-0.75 per cent.

Variations in the type of thermal cracking operations probably influence the sulfur level of the product naphtha from a given charge stock. The order of magnitude of these variations is, however, considerably smaller than the variations noted in Table 1 even at very mild and very severe thermal cracking conditions. Data demonstrating this effect with charge stocks derived from Arabian Crude are shown in Table 2. The data shown in this table were obtained with charge stocks having varying sulfur contents; and in order to put them on a common basis, all data were adjusted to a common charge sulfur content of 1.77 per cent by a ratio factor of the charge stock sulfurs. These data include the two points shown in Table 1 for Arabian Crude.

Since the data shown in Table 2 cover the complete range of thermal cracking operations from single pass gas oil cracking to recycle cracking to coke, it is obvious that the variations in naphtha sulfur shown in Table 1 could not be the result of variations in thermal cracking operations.

There does appear to be an effect, although small, of the type of operation on the sulfur content of the product naphtha; however, any effort to control product naphtha sulfur by variations in the type of thermal operation would be impractical since the refinery balance dictates the type of operation required.

The practical application of charge stock selection is probably quite limited as regards most refiners, especially those located in the vicinity of producing oil fields. There is, even in this instance, however, the definite possi-

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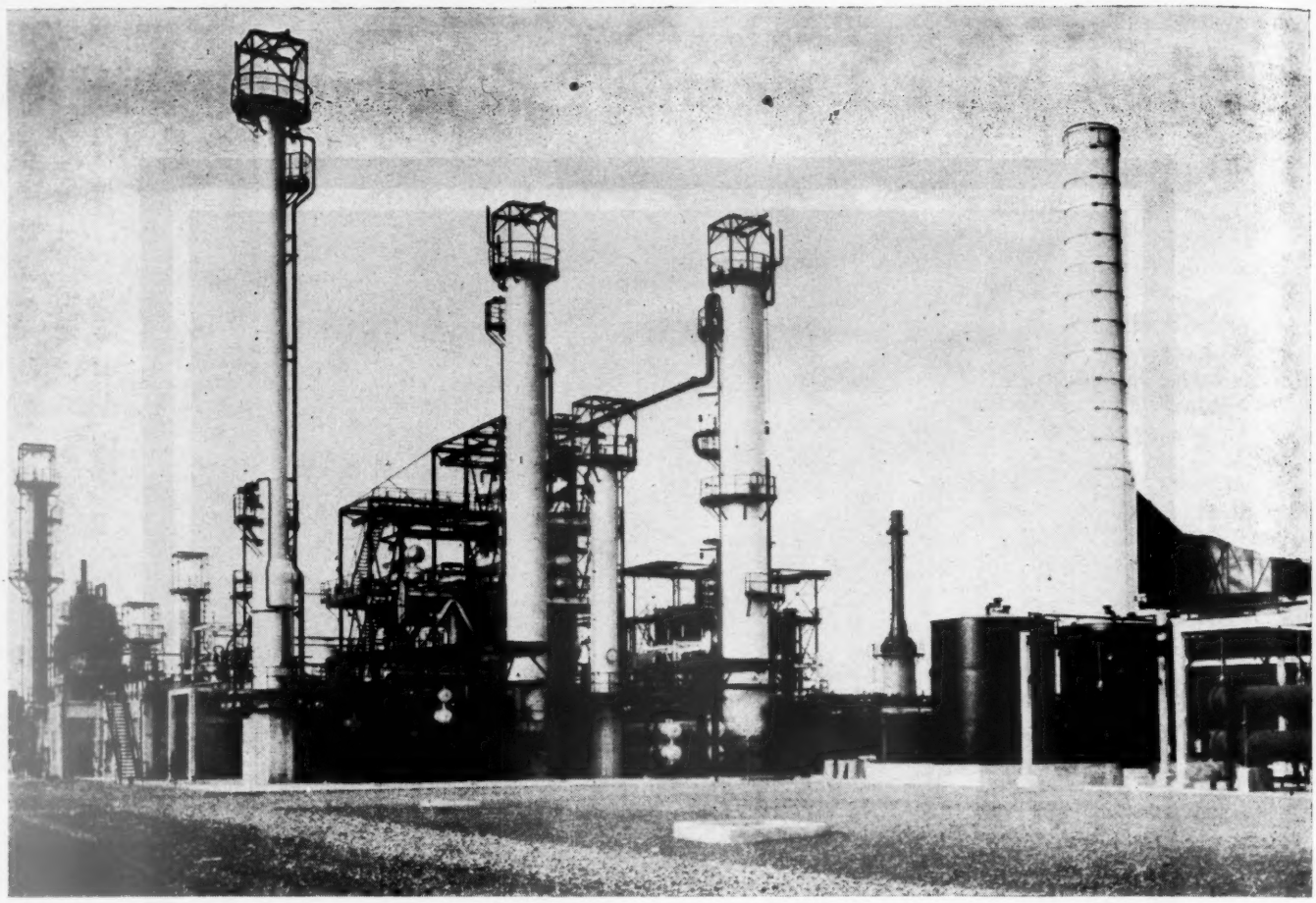

Texaco thermal reforming unit at Eagle Point charges low grade gasoline to obtain a higher octane product, which is then sent to other units for processing.

bility that the evaluation of various charge stocks from different crude sources will show an advantage on sulfur content of the cracked naphtha for one or another of the different crudes. For refiners in seaboard areas receiving crude by tanker from various sources there is a much greater chance that advantage could be taken of the differences that exist between charge stocks from different crudes.

It has been shown above that by the judicious selection of charge stocks for a thermal cracking operation the sulfur content of the product naphtha can be considerably reduced. In the event a selection of charge stocks is impractical, then the charge stock from any given source can itself be treated for sulfur removal prior to being charged to the cracking operation. Any reduction in charge stock sulfur content would be reflected by a decrease in cracked naphtha sulfur, although not necessarily to the same degree. Any method of treating charge stocks for sulfur reduction has the inherent disadvantage that the volume of charge stock which has to be treated is considerably larger than the volume of naphtha which is ultimately desulfurized. Any sulfur reduction method would therefore have to be fairly inexpensive to overcome this feature.

Conventional acid treating of thermal cracking charge stocks can be used to reduce sulfur content although it has one serious disadvantage, namely the degree of desulfurization effected by acid treating in moderate dosages is not large, that is, a desulfurization of probably less than 50 per cent would result. The cost of this operation in terms of chemicals, labor, and equipment would be prohibitive for the sulfur removal obtained in all except very rare cases.

As an alternative to acid treating, hydrogenation of the charge stock under mild conditions would effectively remove the bulk of the sulfur without changing the nature of the charge stock appreciably. With due regard to the technical excellence of this process it cannot be considered generally under present day conditions due to its cost. The high cost of this operation stems from two sources, the cost of hydrogen and the pressure equipment involved. In the event the cost of hydrogen could be cut appreciably from its present level, then serious consideration would be warranted for this type of operation.

Having considered generally the methods of reducing the sulfur content of cracked naphthas from the standpoint of the charging stocks, possible approaches to the reduction of sulfur in cracked naphthas by treatment of the naphtha will be considered.

Normally cracked naphthas are only sweetened and inhibited prior to being blended into finished gasoline. The sweetening is accomplished by conversion of odorous mercaptans into odorless disulfides. Aside from the odor standpoint this treatment does not improve the naphtha to any extent and possibly actually harms the naphtha by the formation of high boiling disulfides. The conversion of the mercaptans into disulfides is in a quantitative range, leaving a residual mercaptan content of about 0.001 per cent.

During the past 10 years sweetening by mercaptan extraction has come into favor with refiners handling high sulfur cracked stocks. There are available several processes which practice this method of sweetening. In these processes the mercaptans are extracted from the naphtha by solutions containing various amounts of caustic

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soda (or potash), organic solvents, and water. The mercaptans are removed from these solutions by either steam stripping or by air oxidation to disulfides and subsequent removal by washing with hydrocarbon oils.

The effluent naphtha in some cases has a very low mercaptan sulfur content and it is claimed will become sweet to the doctor test on standing in tankage; however, in other instances the naphtha is directed to a sweetening unit to insure a sweet naphtha.

This type of operation has the advantage over conventional sweetening of actually removing sulfur containing materials, thereby, reducing the sulfur content of the naphtha. This operation, therefore, receives a credit for a saving in tetraethyl lead not normally associated with sweetening.

In view of the tetraethyl lead saving obtained on sweetening by mercaptan extraction it might be implied that all sweetening could most economically be accomplished by this method; however, this operation is normally more costly than conventional sweetening. The saving to be realized is not of the order of magnitude to compensate for the increased cost of the operation unless the naphtha to be sweetened has a high mercaptan content. The level of mercaptan content required to make the operation attractive is dependent upon such factors as the prevailing lead, sulfur, and octane level at any given refinery; however, in most cases a mercaptan sulfur in the range of 0.1-0.3 per cent is required before the process can pay out the capital investment involved in a reasonable period of time.

Actually the cost of conventional sweetening increases with increasing mercaptan sulfur content while the cost of sweetening by mercaptan extraction is reasonably independent of mercaptan sulfur content; thus, there is a dual effect tending to make mercaptan extraction sweetening more attractive as the mercaptan sulfur content of the charge increases.

The mercaptan sulfur content of a thermally cracked naphtha for some reason is not always related to the total sulfur content of the naphtha. Often the variation between the mercaptan sulfur content of naphtha containing a fixed amount of total sulfur varies through a rather wide range. Some examples of these variations are shown in Table 3.

TABLE 3. Variations in mercaptan sulfur content of thermally cracked naphthas.

Sample	1	2	3
Gravity, °API	55.1	59.6	.....
Sulfur, %			
Total*	0.50	0.59	0.53
Mercaptan†	0.10	0.23	0.34
Mercaptan sulfur distribution, grams (RSH-S) / liter†			
Start —85 F	2.2	6.7	.....
85 F—125 F	1.4	3.1	.....
125 F—180 F	1.3	2.5	.....
180 F—235 F	0.7	1.6	.....
235 F—279 F	0.4	1.0	.....
Bottoms	0.3	0.7	.....
Motor octane			
Clear	72.1	68.8	69.5
+ 3ml. TEL/gal	76.8	73.3	73.7

* Lamp
† Potentiometric

TABLE 4. Desulfurization methods for thermally cracked naphtha.

Operation	Desulfurization	Characteristic features
1. Mercaptan extraction	15–45%. Depends on mercaptan content of naphtha and sulfur reentry.	Product has low mercaptan content. May require sweetening.
2. Catalytic vapor phase desulfurization. Regenerative operation.	<65%. Depends on frequency of regeneration.	Product has low mercaptan content. May require sweetening.
3. Acid treating.	< 80%. Depends on acid dosage.	Product requires sweetening. Yield loss > 20% @ good sulfur reduction.
4. Mild hydrogenation.	> 90%. Usually runs closer to 100%.	Olefins hydrogenated with resultant marked drop in octane number.

It is immediately obvious that the No. 3 stock will be the most desirable from the standpoint of sweetening by mercaptan extraction in view of the extreme mercaptan sulfur content. Earnings from a reduction in tetraethyl lead requirements will be about 3 to 4 times as large with this stock as with the No. 1 stock, which has about the same total sulfur content as the No. 3 stock. The net sulfur reduction which would result from complete mercaptan removal may be as high as 65 per cent; however, this figure usually tends to be lower as a result of some sulfur reentry from the treating solution.

General treating methods for sulfur reduction are summarized in Table 4 which includes for purposes of comparison mercaptan extraction.

Probably the most serious disadvantage of mercaptan extraction as a method of sulfur removal is the limitation in the degree of desulfurization as fixed by the mercaptan content of the naphtha. Where greater desulfurization is required than can be obtained by mercaptan removal, other desulfurization methods must be employed. In these circumstances, regenerative catalytic vapor phase desulfurization is to be preferred over other methods since the process is not subject to appreciable yield loss or octane depreciation as are acid treating and mild hydrogenation, respectively.

It should not be inferred from Table 4 that mercaptan extraction processes can approach desulfurization resulting from regenerative catalytic vapor phase desulfurization since this latter process removes essentially all the mercaptans and, in addition, a substantial portion of other types of sulfur compounds. With naphthas containing large proportionate quantities of mercaptan sulfur basis total sulfur (Stock 3, Table 3), regenerative catalytic vapor phase desulfurization may yield products which are desulfurized to a greater extent than has been indicated. The 65 per cent figure for catalytic vapor phase desulfurization shown in Table 4 may be considered as a typical figure and not as an absolute maximum.

The question as to whether a sweetening operation is required after the mercaptan extraction process is not clearly defined. In some instances it is definitely necessary to sweeten after a mercaptan extraction operation while in other cases it is claimed the naphtha will sweeten in tankage. The necessity for an after sweetening operation will have a marked bearing on the economics of mercaptan extraction operations since the investment and operating cost of a sweetening unit, although moderately low, does represent an appreciable cost item in finished gasoline.

The possibility of a doctor sweet naphtha being produced by regenerative catalytic vapor phase desulfurization should not be overlooked. In commercial operations with straight run naphtha in a non-regenerative process all that is required in some cases to produce a doctor sweet product is to incorporate a caustic washing step with the desulfurization step.

Summarizing: The sulfur content of a thermally cracked naphtha can be reduced by (1) selection of the crude source of the charge stock, (2) sulfur removal from the charge stock, and (3) sulfur removal from the product naphtha.

Selection of the crude source of the charge to a thermal unit cannot be varied widely, except in unusual circumstances; however, where the choice is available between several crudes of similar total sulfur content, a marked reduction in sulfur in the cracked naphtha can be effected.

The economics of treating the charge stock to a thermal operation for sulfur reduction are generally such that the savings realized in tetraethyl lead are not sufficient to pay for the cost of the operation.

Treating of product naphtha for sulfur reduction offers an economical solution only when the yield and quality loss (octane) do not more than offset the savings to be realized. * *

April Motor Fuel Survey Shows Octane Rating Rise

Results of the April, 1950 survey of motor fuel octane ratings, and other properties of motor gasolines in these United States show that, while variations occur in many instances, the general trend is upward, as all studies in this field to date show.

This individual study, carried out by the Petroleum Chemicals Division of the duPont Company, shows that there exists a remarkable similarity between the octane rating range of regular or housebrand gasoline and of premium grade motor fuel, as it relates to the difference in these fuels in the lowlands of the United States and the range in the mountain or highlands regions of the country. For example, for Boston, Massachusetts, the regular brand motor fuels ratings for October, 1949 and April, 1950 are 79.4 and 79.9, respectively; for Cincinnati, Ohio, 77.9 and 78.7; Louisville, Kentucky, 78.4 and 79.6; for St. Louis, Missouri, 76.3 and 77.5.

Differences in TEL content range from the average of 2.44 cc. at Amarillo, Texas, and 2.38 cc at Louisville, Kentucky, to 1.14 cc at Detroit, Michigan, home of the worst motor fuel fight in the nation. In general the trend from October, 1949 and January, 1950 to April, 1950 is down in each case, meaning that while seasonal trends are downward in winter and upward in summer, the average trend is for lower TEL consumption in the same seasonal period, other things being equal.

Kansas City, Missouri, shows the least seasonal variation in lead content. By contrast, at Montreal, Quebec, the averages for the seasons are widely varied. At the same time the octane ratings indicate that the trend in the populous part of Canada is upward. The upward trend of the East is indicated by the Philadelphia figures.

In general, the variations in octane ratings in the mountain areas in the U. S. are smaller than these differences in the lowland regions. For example, at Casper, Wyoming, the average difference between regular and premium motor fuel is the difference between 88 and 82 Research octane numbers. For Memphis, Tennessee, the difference is 5 octane numbers; at Indianapolis, 83 and 88 octane numbers. Little difference this is, to be sure; in fact for the entire country, the average between regular and premium gasoline may be said to be six numbers, a normal margin. * * *

	PREMIUM									REGULAR								
	OCTANE NUMBER						TEL CONTENT cc/gal.			OCTANE NUMBER						TEL CONTENT cc/gal.		
	MOTOR			RESEARCH						MOTOR			RESEARCH					
	Oct.	Jan.	April	Oct.	Jan.	April	Oct.	Jan.	April	Oct.	Jan.	April	Oct.	Jan.	April	Oct.	Jan.	April
Aberdeen, South Dakota	—	—	79.7	—	—	86.6	—	—	2.23	—	—	76.2	—	—	80.4	—	—	1.49
Amarillo, Texas	78.6	78.4	79.3	85.8	86.0	87.7	2.19	2.64	2.55	75.2	74.9	75.9	79.5	78.6	80.3	2.19	1.97	2.44
Atlanta, Georgia	81.0	81.5	82.2	89.2	90.0	91.0	1.56	1.63	1.67	77.9	78.5	79.2	84.7	83.9	84.9	1.85	1.70	2.00
Bakersfield, California	84.0	83.8	83.1	87.7	89.0	88.8	2.73	2.58	2.50	76.0	77.1	75.5	80.2	81.5	80.6	1.96	1.83	1.56
Baltimore, Maryland	81.5	81.4	82.1	90.6	90.8	91.8	1.54	1.52	1.49	78.0	78.5	79.4	83.8	85.3	85.6	1.28	1.40	1.25
Boston, Massachusetts	82.0	82.1	83.0	90.3	91.1	91.5	2.04	1.68	2.10	79.4	78.7	79.9	85.0	85.6	86.4	1.81	1.41	1.60
Calgary, Alberta	—	—	76.4	—	—	84.4	—	—	2.10	—	—	74.0	—	—	79.3	—	—	1.88
Casper, Wyoming	79.7	78.8	78.5	88.4	88.6	88.1	1.36	1.18	1.60	74.6	75.1	74.4	80.4	81.6	82.0	1.08	0.89	0.95
Charlotte, North Carolina	—	—	82.0	—	—	90.9	—	—	1.54	—	—	79.2	—	—	84.8	—	—	1.72
Chicago, Illinois	79.6	80.0	81.2	85.5	86.9	88.2	1.96	1.75	1.97	75.7	76.5	77.4	80.9	81.4	82.6	1.67	1.43	1.60
Cincinnati, Ohio	81.7	80.9	81.6	88.7	90.2	89.8	2.37	1.53	1.76	77.9	77.8	78.7	83.4	84.8	85.1	2.37	1.27	1.38
Cleveland, Ohio	81.7	80.5	81.4	89.6	89.9	89.8	2.10	1.74	2.03	77.6	77.6	78.2	84.4	84.9	85.2	1.39	1.00	1.41
Columbus, Ohio	82.1	81.2	81.5	89.8	90.0	89.8	2.34	2.23	2.10	78.1	78.2	78.5	84.6	84.4	85.4	1.69	1.54	1.40
Corpus Christi, Texas	81.8	82.0	82.8	90.5	89.6	92.2	1.28	1.79	1.65	77.7	79.4	79.0	83.3	83.8	85.1	1.19	1.24	1.58
Dallas, Texas	80.6	81.1	81.5	88.4	89.0	92.0	2.56	2.63	2.27	76.9	77.0	77.7	83.2	82.9	84.0	2.25	2.22	2.00
Denver, Colorado	79.7	79.4	78.4	88.2	88.6	87.6	1.78	1.31	1.09	75.2	76.0	75.0	80.3	81.9	81.4	1.25	0.95	0.88
Detroit, Michigan	81.6	80.3	81.6	88.4	89.5	90.2	2.18	1.82	2.04	77.4	77.2	78.0	83.3	84.2	84.2	1.58	1.12	1.14
El Paso, Texas	76.8	78.1	78.0	84.4	84.2	85.5	2.87	2.52	2.43	70.5	71.6	71.0	75.2	76.7	76.5	1.49	1.12	1.47
Great Falls, Montana	77.9	77.2	77.8	85.5	85.2	87.1	2.55	1.81	1.78	73.6	74.6	73.2	80.0	81.4	80.8	1.38	1.03	0.89
Houston, Texas	80.9	81.9	82.4	89.5	90.0	92.2	2.01	1.79	2.03	76.9	78.3	78.8	83.3	83.8	84.9	1.68	1.45	1.86
Indianapolis, Indiana	—	—	80.7	—	—	88.1	—	—	2.58	—	—	77.3	—	—	83.0	—	—	1.95
Jacksonville, Florida	—	—	81.8	—	—	90.6	—	—	1.52	—	—	79.1	—	—	85.6	—	—	1.61
Kansas City, Missouri	78.8	80.9	81.8	87.0	88.2	89.6	1.93	2.34	2.12	76.1	76.6	77.5	81.3	81.7	82.8	1.71	1.55	1.74
Little Rock, Arkansas	—	—	82.5	—	—	90.6	—	—	2.20	—	—	79.0	—	—	84.2	—	—	1.78
Los Angeles, California	80.8	80.2	80.8	90.0	90.1	90.1	2.22	1.79	2.17	76.6	75.5	75.3	82.3	83.3	82.8	1.46	1.16	1.30
Louisville, Kentucky	81.0	81.5	83.1	88.1	89.5	90.9	2.50	2.12	2.41	78.4	78.5	79.6	82.8	83.5	84.5	2.34	2.30	2.38
Memphis, Tennessee	80.9	81.2	82.1	88.7	89.6	90.2	1.84	2.18	2.25	78.1	78.3	78.9	83.9	84.3	84.8	2.06	1.96	1.97
Milwaukee, Wisconsin	80.8	81.1	80.8	88.2	88.0	88.3	1.72	1.92	2.27	75.3	75.5	77.0	81.1	80.6	82.4	1.61	1.36	1.70
Minneapolis, Minnesota	79.7	80.9	82.2	85.8	86.9	87.6	2.19	2.20	2.39	75.0	76.2	76.1	79.7	81.3	80.6	1.57	1.62	1.43
Montreal, Quebec	81.4	81.5	80.9	86.8	88.0	88.7	1.73	2.14	1.99	77.2	77.3	78.3	82.4	82.5	84.2	1.22	1.17	1.75
Nashville, Tennessee	—	81.1	81.9	—	89.8	90.5	—	2.00	2.06	—	77.8	78.4	—	84.2	84.7	—	1.96	1.85
New Orleans, Louisiana	80.8	81.1	82.1	88.6	89.1	90.5	2.20	2.01	2.16	77.9	77.9	78.8	83.5	83.2	85.6	2.24	1.84	2.17
New York, N. Y. (Metropolitan Area)	81.6	80.8	82.2	89.2	90.3	90.8	1.74	1.52	2.13	78.5	78.5	79.3	84.3	84.9	85.4	1.42	1.26	1.53
Omaha, Nebraska	—	—	81.8	—	—	88.3	—	—	2.53	—	—	76.6	—	—	80.9	—	—	1.41
Philadelphia, Pennsylvania	80.9	81.0	83.0	89.7	90.1	91.7	1.54	1.57	1.86	77.6	77.7	79.3	84.5	85.1	86.4	1.35	1.14	1.58
Pittsburgh, Pennsylvania	82.0	81.7	83.0	90.8	91.2	91.6	1.94	1.84	2.17	78.7	78.2	79.6	84.5	85.5	85.8	1.82	1.42	1.95
St. Louis, Missouri	80.2	80.7	81.2	86.4	87.6	88.9	1.83	2.04	2.14	76.3	76.6	77.5	81.5	81.6	83.3	1.51	1.55	1.61
Salt Lake City, Utah	80.0	80.0	79.8	87.7	88.8	88.5	1.38	1.38	0.87	72.9	73.5	74.3	78.4	79.8	80.1	1.06	1.16	0.81
San Francisco, California	82.2	81.6	81.8	90.7	91.5	90.7	2.26	2.01	1.96	75.9	75.8	75.4	81.9	83.2	83.2	1.47	1.20	1.18
Seattle, Washington	82.5	81.2	81.9	90.8	91.2	90.9	2.26	1.65	1.73	75.9	76.0	75.7	81.4	83.4	82.7	1.47	0.92	1.31
Shreveport, Louisiana	—	81.2	81.8	—	87.7	89.8	—	2.71	2.54	—	78.3	79.4	—	82.8	84.4	—	2.24	2.18
Spokane, Washington	—	—	79.6	—	—	89.1	—	—	1.51	—	—	74.3	—	—	82.4	—	—	1.19
Toronto, Ontario	78.7	80.2	80.3	86.3	87.0	87.0	1.99	2.40	2.36	76.5	76.2	76.3	82.2	81.7	82.4	1.57	1.45	1.78
Tulsa, Oklahoma	80.2	80.2	81.2	87.2	87.1	88.6	2.51	2.47	2.57	75.8	76.3	77.1	80.7	81.0	81.3	1.91	1.74	1.95
Wichita, Kansas	78.5	78.5	79.0	85.7	85.9	86.8	2.45	1.88	2.11	75.7	76.5	77.0	80.0	80.9	81.3	1.94	1.86	1.81

Natural Gas Invades Fuel Oil Markets

Condensed from "Fuel Oil Markets—Past and Future," presented by A. J. McIntosh, Socony-Vacuum Oil Company, before Western Petroleum Refiners Association, March 27-29, 1950.

PRACTICALLY all increase in the use of liquid fuels from crude petroleum during the period 1950-53 will be neutralized by the increased use of natural gas, Albert J. McIntosh, economist for Socony-Vacuum Oil Company told the assembled Western Petroleum Refiners in San Antonio, Texas late in March. Distillate and diesel oils will show substantial increase, which will be offset by losses in consumption of kerosine and residual fuels. Some of the kerosine loss will be traceable to increased use of liquefied petroleum gases, the remainder of it will be due to natural gas received in the north and east via the new gas lines recently built and those being built.

Total requirements for liquid fuels for 1953 may be only one per cent above 1950; trends in later years will depend on further developments in distribution and use of natural gas. The refiner then must look forward to the proper choice of the amounts of various products he is to make, if he is to "hit the market" satisfactorily, without surplus-this and shortage-that to throw his operations out of balance. The liquid fuel equivalents of additional natural gas to be consumed in 1951 is estimated at 283,000 bbl per day; for 1952, 166,000 bbl per day, and for 1953 to a mere trickle, 69,000 bbl per day. In short, the biggest impact on the liquid petroleum industry will be next year, from natural gas inroads; this opinion is based on existing plans for projected gas lines and if new systems are projected later, the situation may change importantly.

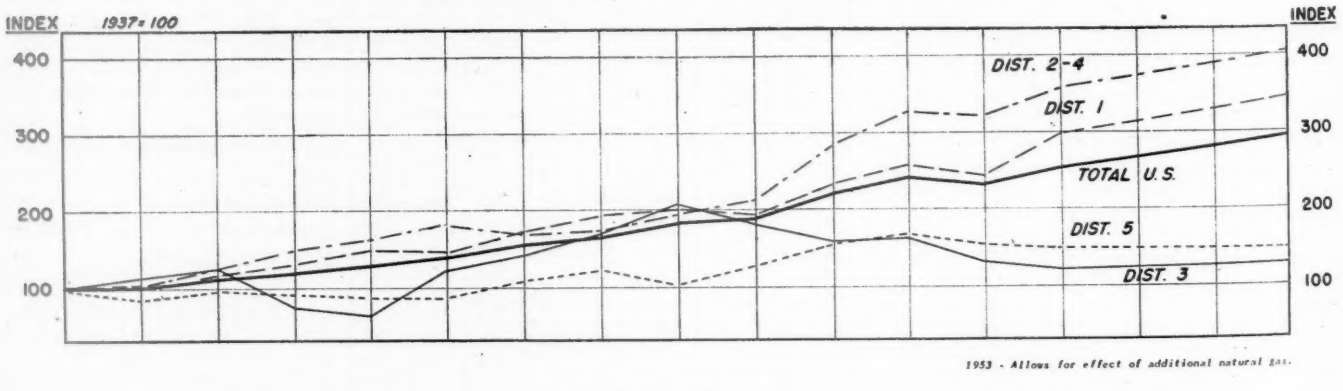
The yield of motor fuel—gasoline—for 1953 is estimated at an all-time high of 46 per cent of the crude processed; all fuels totals will drop 44½ per cent of the barrel in 1950 to less than 42 per cent in 1953. Residual fuel will drop far more than this average value; if heavy fuel imports remain at about the present level the American refiner must plan to take three per cent less residual fuel from this crude than at present. If imports drop in volume, the domestic refiners' demand will increase correspondingly, for heavy fuel oil.

These estimates indicate that we must "get set" for new and greater all-time highs for distillate fuels, diesel fuels, motor fuels. We have passed, probably, the peak yield of kerosine; the trend to less residual fuel production will be speeded up, likely.

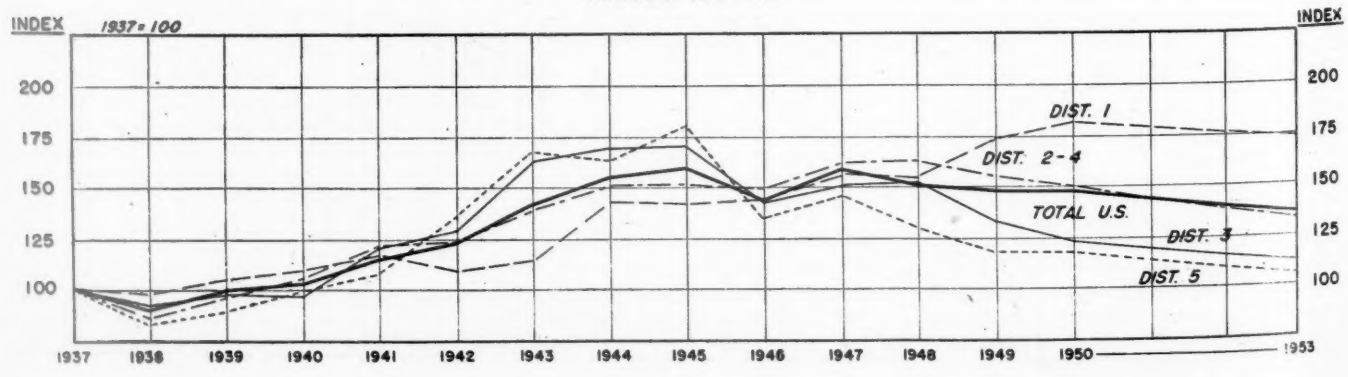
Outstanding in the increases in fuel oil consumption is that of the use of diesel and distillate fuels by railroads. A negligible amount in 1941, the demand will rise to more than 100,000 bbl per day in 1950, and estimated at 200,000 bbl per day by 1953. This rate of increase agrees qualitatively with the reported increase in locomotives burning distillate fuels, and the practical elimination of coal or residual fuel oil burning engines on order by American railroads. At the same time use of heavy residuals for heating has practically disappeared from the American scene. ★ ★ ★

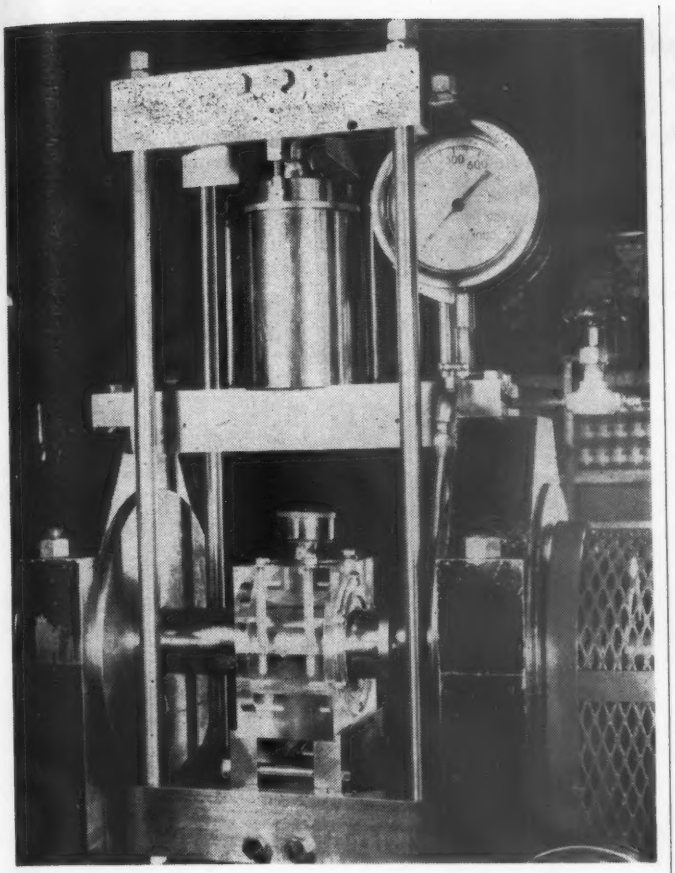
TRENDS OF FUEL OILS USED BY DISTRICTS IN UNITED STATES

Total diesel and distillate fuel oils (including 1-range oil).



Residual fuel oil.





Texaco test machine with lucite bearings.

Plastic Bearing Aids Lube Tests

A transparent plastic bearing for lubrication studies has been built by The Texas Company. Using this unit, engineers can see and photograph the behavior of oils and greases in bearings under different loads and speeds. Bright red dye is mixed with the lubricant so that the lines of flow can be followed. Sensitive scales on the test machine measure the friction drag—the tendency of the bearing to rotate with the shaft. Operating temperatures are measured electrically by means of thermocouples and a potentiometer.

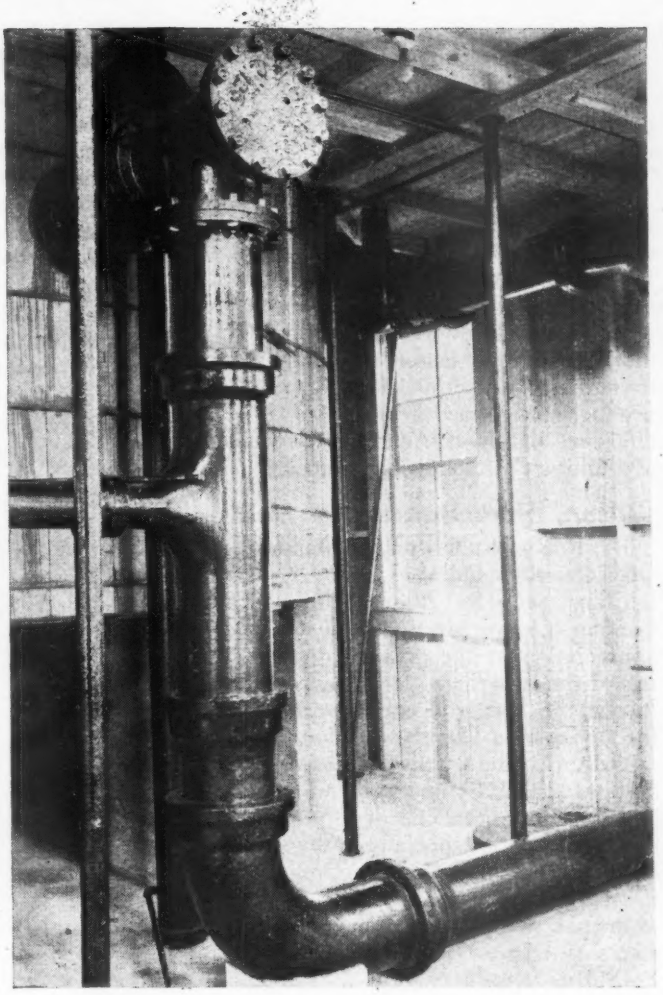
The special test machine and lucite bearing were designed and built at the Texaco research laboratories at Beacon, New York. The work is being done at the Engineering Experiment Station of the Pennsylvania State College.

John Scott Awards Made

For their contributions to the art of stabilizing cracked gasoline, Dr. Roy G. Story, of Swift and Company, Chicago, and Harry T. Bennett, of Mid-Continent Petroleum Corporation, Tulsa, were given the John Scott Award. Presentation was made at an oil refiners' dinner meeting at the Hotel Cleveland, Cleveland, Ohio, May 3. The award includes copper medals and cash premiums of $1,000 for each of the recipients.

Dr. Story, head of the Patent Division for Swift, has been engaged for a number of years in research work in various phases of the petroleum industry, including the stabilization of cracked gasoline and the composition of phenolic and sulfur compounds in gasoline.

Bennett, an alumnus of the Universities of Delaware and Nebraska, served on the Nebraska and Missouri universities faculties. In 1917 he joined Mid-Continent, where he now heads research as technical director. His name is widely associated with solvent extraction of lubricants by means of Chlorex, on which work he holds basic patents.



DIRECT ROUTE TO LOWER PLANT MAINTENANCE

The direct and indirect expense of replacements of short-lived refinery pipe lines can be reduced, or avoided altogether, by the use of cast iron pipe. This has been proved by many refineries whose maintenance costs have been lowered by replacing other pipe materials with cast iron.

A relatively low first-cost material, cast iron pipe is usually cheapest in the end, for many refinery applications, because of its stubborn resistance to corrosion. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints.

Cast Iron Pipe Research Association,
Thomas F. Wolfe, Engineer,
1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
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NEWS

Phillips Will Build 30,000-Bbl Cat Cracker

Plans have been announced for a new 30,000-bbl catalytic cracking unit at the Phillips Petroleum Company's Phillips, Texas refinery. Completion is expected in August, 1951, and construction is to begin within the next few months. This will enable the company to increase production of high quality products and reduce the output of residual fuel oils, K. S. Adams, president of Phillips Petroleum, announced.

Wilson, Hart Honored

Dr. Robert E. Wilson, of Standard Oil Company (Indiana), and Dr. W. B. Hart, of The Atlantic Refining Company, were given certificates of appreciation by the division of refining of the American Petroleum Institute at the 15th mid-year meeting of the division in Cleveland, Ohio.

Wilson is chairman of the board of Standard Oil Company (Indiana), and long has been one of the oil industry's leaders, especially in the field of research. Hart, an expert on disposal of refinery wastes, is in charge of the gas, acids, and drainage departments of Atlantic Refining Company's Point Breeze refinery.

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El Dorado Refinery Contracts for New Cat Cracker

R. T. Colquette, general manager, Pan-Am Southern El Dorado refinery, has announced that a contract had been signed with the Foster Wheeler Corporation to construct a second Fluid catalytic cracking and vapor recovery unit at the El Dorado, Arkansas, refinery.

The new catalytic cracking facilities include all the latest proved innovations in design and will process 9000 bbl a day of gas oil to high octane gasoline and furnace oil. These facilities, together with the coking unit now under construction, will increase the refinery crude capacity about 20 per cent or to 30,000 bbl a day and permit production of 16,500 bbl daily of motor gasoline.

Under construction presently is a new coking unit with completion scheduled in September.

R. J. Diwoky, Pan-Am vice president, is signing contract. Seated next to him is J. E. Kenney, vice president, Foster Wheeler. Standing are J. W. Bertetti, technical director, J. B. Hamblen, general manager of manufacturing, and R. T. Colquette, general manager, El Dorado refinery.

R. W. McDowell Elected President of WPRA

New officers and directors for Western Petroleum Refiners Association were elected at the annual meeting held recently in San Antonio, Texas. They are: R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa, president; F. L. Martin, Sunray Oil, Tulsa, Roland V. Rodman, Anderson-Prichard, Oklahoma City, R. L. Tollett, Cosden Petroleum, Big Spring, and H. E. Zoller, Derby Oil Company, Wichita, Kansas, vice presidents; John C. Day, Tulsa, secretary treasurer; Fayette B. Dow, Washington, D. C., general counsel.

Board of directors: R. W. McDowell, Mid-Continent Petroleum, Tulsa, R. G. Bandy, Midland Cooperative, Cushing, Paul G. Blazer, Ashland Oil & Refining, Ashland, Kentucky, Reid Brazell, Leonard Refineries, Inc., Alma, Michigan, Rex S. Blazer, Allied Oil, Cleveland, Ohio, H. W. Camp, Cities Service, Bartlesville, Sheldon Clark, Sinclair Refining, Chicago, Illinois, O. L. Cordell, Bareco Oil, Tulsa, W. J. Carthaus, Deep Rock Oil, Tulsa, F. H. Dunn, Wilcox Oil, Tulsa, A. M. Hughes, Phillips Petroleum, Bartlesville, T. A. Helling, El Dorado Refining, El Dorado, R. R. Irwin, Socony-Vacuum Oil, Kansas City, Missouri, Harry J. Kennedy, Continental Oil, Ponca City, J. P. Langfitt, Pure Oil, Chicago, R. E. Luton, Ohio Oil Company, Findlay, F. L. Martin, Sunray Oil, Tulsa, T. M. Martin, Lion Oil, El Dorado, Brown L. Meece, Globe Oil and Refining, Chicago, Roland V. Rodman, Anderson-Prichard, Oklahoma City, M. H. Robineau, Frontier Refining Company, Cheyenne, Wyoming, R. L. Tollett, Cosden Petroleum, Big Spring, J. W. Vaiden, Skelly Oil, Tulsa, J. W. Warner, Tide Water Associated, Tulsa, and H. E. Zoller, Derby Oil, Wichita, Kansas.

Ex-Officio directors are: H. T. Ashton, Socony-Vacuum Oil, St. Louis, and C. M. Boggs, Kanotex Refining, Arkansas City.

Publish 1950 Appendix to ASTM Engine Test Manual

The 1950 appendix to the American Society for Testing Materials Manual of Engine Test Methods for Rating Fuels has been made available to the public.

Issued in January, the appendix was prepared by the division on combustion characteristics of ASTM Committee D-2 on petroleum products and lubricants. It includes changes through 1949 in the 1948 ASTM Manual of Engine Test Methods for Rating Fuels.

The following summary shows the material included in the 1950 appendix, and indicates those sections of the original knock test manual that have been revised:

Optional Use of Detonation Meter for Motor (D 357) and Research (D 908) Methods.

Table 1A. Micrometer Settings for Standard Knock Intensity at a Barometric Pressure of 29.92 in. of Mercury—For detonation meter only. For use at altitudes from sea level to 1600 ft, 9/16 in. Venturi.

Table VA. Micrometer Settings for Standard Knock Intensity at a Barometric Pressure of 29.92 in. of Mercury—For detonation meter only. For use at all altitudes, 9/16 in. Venturi.

Revised Reproducibility Sections for Motor (D 357), Research (D 908), Aviation (D 614), Supercharge (D 909), and Cetane (D 613) Methods.

Table XXIII. ASTM Conversion for Octane Numbers to Performance Numbers (covers octane numbers from 70 to 100).

Table XXIV. ASTM Conversion for Tetraethyllead in Isooctane to Performance Numbers (covers Tetraethyllead content from 0 to 6 ml).

Revisions in Aviation Method and in Supplements II and IV.

Proposed Carburetor Jacket for Use with Motor and Research Methods to Rate High Vapor Pressure Fuels.

Table XXV. List of Equipment changes to January 1, 1950.

Table XXVI. Summary of Equipment and Conditions for ASTM Engine Test Methods. (This table supplements the summary of operating conditions in Table XV of the 1948 manual.)

Table XXVII. Recommended Torque Values for ASTM-CFR Engines.

Table XA. ASTM Octane Number Conversion for Blends of Standardization Fuel X-6 and n-Heptane.

Errata and Editorial Changes in the 1948 Manual.

Completes Venezuelan Plant

Venezuela Gulf Refining Company has completed its new plant at Puerto La Cruz, Venezuela. The plant has a daily capacity of 30,000 bbl and is owned two-thirds by the Gulf Oil Corporation and one-third by The Texas Company through their operating subsidiaries in Venezuela. Gasoline, furnace oil, diesel fuel oil, and heavy fuel oil, which will be sold in world markets, are principal products of the plant.

Builds Belgium Refinery

Construction is now under way on a complete 30,000 bbl-per-day refinery for the Société Industrielle Belge des Pétroles at Antwerp, Belgium. The contract for the work is held jointly by The M. W. Kellogg Company and its European subsidiary, Kellogg International Corporation.

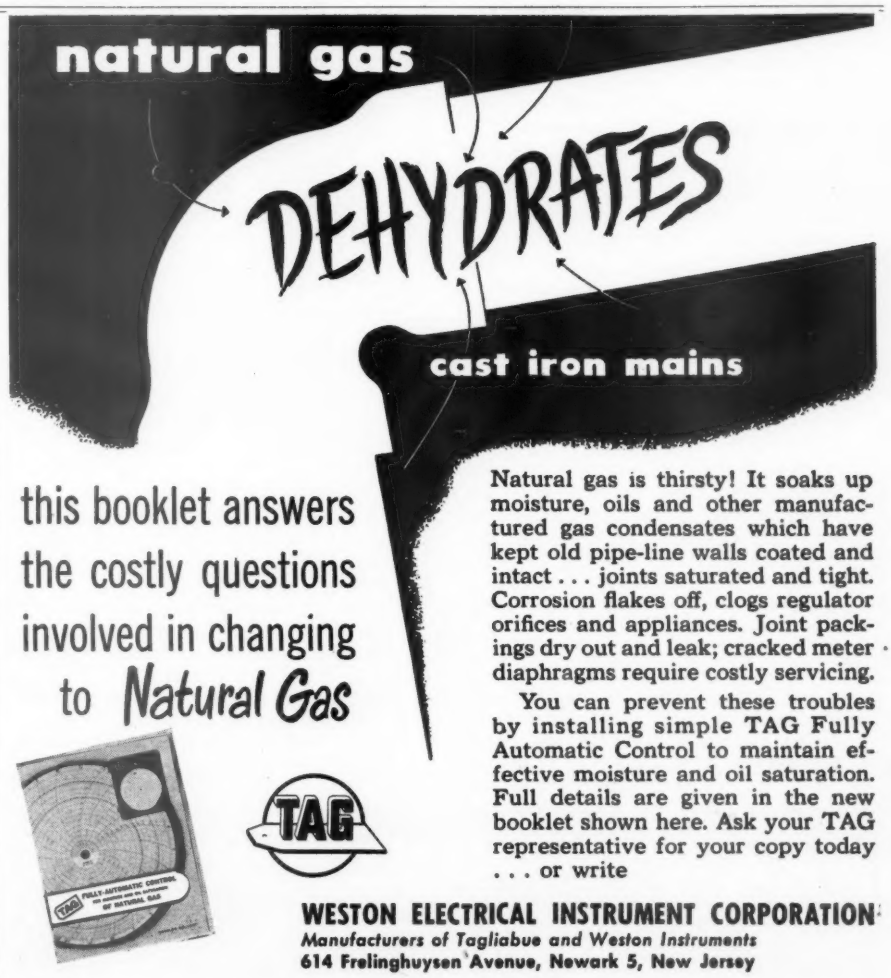
An indication of the recovery of European industry since the end of the war is seen in the fact that Kellogg International Corporation is directing the purchase of a major portion of all materials and equipment for this multimillion-dollar project from Belgian and other non-dollar manufacturing areas.

As part of the over-all industrial expansion in Europe, the new plant, being financed by Belgian interests, will utilize normal refining processes and will have facilities for operation as a completely integrated refinery. The refinery is situated on a site adjacent to the Scheldt River, and extensive development work is being undertaken by the Port of Antwerp Authority to improve facilities for the ships that will bring the crude oil to this refinery. In planning the refinery, sufficient space has been provided for the future addition of process units to produce additional products, such as lubricating oils and high octane gasoline. Completion is scheduled for mid-1951.

Completes Benedum Field Gasoline Plant

Completion of a natural gasoline plant near Rankin, Texas, to process gas produced from the Benedum field in Upton and Reagan Counties, has been announced by John T. Oxley, president of Texas Natural Gasoline Corporation. This plant, which is situated about 17 miles northeast of Rankin, recently began full operations.

The Benedum plant capacity is 55,000,000 cu ft of gas daily, with a recoverable production of 200,000 gal of natural gasoline and LPG.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Natural gas is thirsty! It soaks up moisture, oils and other manufactured gas condensates which have kept old pipe-line walls coated and intact . . . joints saturated and tight. Corrosion flakes off, clogs regulator orifices and appliances. Joint packings dry out and leak; cracked meter diaphragms require costly servicing.
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Chemical and Pipeline Companies Join in Venture

Mathieson Hydrocarbon Chemical Corporation is a joint venture just begun between Mathieson Chemical Corporation and shareholders of Tennessee Gas Transmission Company. The new company will produce a number of hydrocarbon-derived chemicals, beginning with the hydrocarbons in the gas stream of the Tennessee Company in its lines conducting gas from Texas and Louisiana to the eastern and northern consuming areas. The new company has acquired control of more than 2000 acres of land near Brandenburg, Kentucky, on the Ohio River southwest of Louisville. A new plant to cost $17,000,000 will be completed at that site by the end of 1951. A raw materials plant to cost $6,000,000 will be built to supply this plant.

Tennessee Gas is building also a $12,000,000 stripping plant to recover the hydrocarbons from the gas stream, and these hydrocarbons will be transported to the chemical plant via pipe line. Officials of the new company are T. S. Nichols, president; J. C. Leppart, vice president; Carl F. Prutton, vice president, operations, and S. de J. Osborne, secretary-treasurer.

Controlled Odorization

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TITRILOG

CONSOLIDATED TITRILOG
Model 26-102

Accurate control of the odorization of natural gas is a major problem facing many gas distribution companies today. The importance of odorizing gas to a known and fixed level, in order to assure its safe and economical distribution, is ever increasing with the rapid expansion of natural gas utilization.

The Consolidated Titrilog is now being used in production plants and on distribution lines to continuously record the concentration of the odorant in the stream. Thus, a constant odor level in the gas is insured and a permanent record is acquired for legal evidence of effective odorization.

The Titrilog quantitatively records sulfur compounds such as H_2S, SO_2, mercaptans, thioethers, thiophene, and organic disulfides in concentrations as low as 0.1 ppm or 0.005 grains per 100 cubic feet. Compounds of specific interest may be separately determined over a wide range of concentrations.

For complete information on the Consolidated Titrilog and other applications, such as problems in corrosion, sour-gas treating, etc., write for Bulletin CEC-1810-X7.

SPECIFICATIONS

Sensitivity The Titrilog quantitatively records oxidizable sulfur compounds in concentrations as low as one part in ten million or 0.005 grains per 100 cubic feet.

Power Requirements The Titrilog operates on standard 60-cycle 115-volt power. It requires approximately 6 amperes.

Cabinet Dimensions The Model 26-102 Titrilog is housed in a floor-mounted cabinet 66-inches high, 22½-inches wide, and 18½-inches deep. The strip-chart recording milliammeter is mounted at eye level, and directly below it is the control panel.

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Shamrock Gets Cracking Unit

The Shamrock Oil and Gas Corporation will install a Houdriflow catalytic cracking unit at its McKee refinery near Sunray, Texas, J. H. Dunn, president of Shamrock, and Brig. Gen. D. N. Hauseman, president of Houdry Process Corporation, have announced.

The new unit will be of the most modern design and will have a design fresh charge capacity of 5900 bbl per stream day, with additional capacity to permit recycling for increased gasoline production.

Construction of the new unit will be handled by the Catalytic Construction Company of Philadelphia, Pennsylvania. Work will proceed immediately, and completion is expected by early 1951.

Mexican Petroleum Plan To Build Asphalt Refinery

Officials of Mexican Petroleum Corporation have announced plans for the construction of an asphalt refinery of about 2000-bbl daily capacity at Wilmington, North Carolina. Construction work is to begin in the near future on the refinery, which will produce primarily paving asphalt for the local market in the Carolinas. Completion is set for late fall.

Loading facilities and storage will be erected for from 150,000 to 200,000 bbl. Crude will be brought by tanker, and reduced to finished asphalt in the refinery. Mexican Petroleum is a subsidiary of Pan American Petroleum and Transport Company, Inc., (Standard Oil Company, Ind.)

California Refining Gets Three Treating Units

The Catalytic Construction Company has been awarded a contract to construct three gasoline treating units for the California Refining Company at its Barber, New Jersey plant. Construction will begin immediately on two lead sulfide sweetening plants and a reagent plant. Completion is scheduled for August.

Begins Manitoba Refinery

Premier D. L. Campbell of Manitoba officially began construction of Imperial Oil's new 10,000-bbl per day refinery at East St. Paul on April 24, when he turned the first sod on the 400-acre site. Completion of the site, estimated to cost $10,000,000, is scheduled for May, 1951.

The refinery has been made possible by the new Edmonton-Lake Superior pipe line, which will provide low-cost transportation for Alberta crude oil. Winnipeg will be supplied from a take-off point at Gretna.

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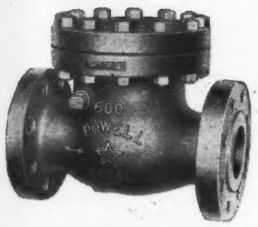

Fig. 6061 — Class 600-pound Cast Steel Swing Check Valve. Flanged ends and bolted flanged cap.

When you want to buy a new suit, you don't shop for the coat in one place, the vest in another, and the trousers in still another.

But that's just what you do if you get your bronze or iron valves from one source, cast steel valves from another and possibly special design or alloy valves from several others.

No one makes better bronze, iron or steel valves than we do. And, in the field of special design and alloy valves for corrosion-resistance, Powell has always led the way. Today Powell makes the *only* COMPLETE line of these valves available.

In short, Powell makes all kinds of valves* needed in your industry—and makes them better. So stop shopping for valves. Standardize on Powell . . . and centralize responsibility for the efficient operation of the entire flow control system in your plant.

Fig. 6079 — Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Bevel gear operated. Also available in Classes 150, 300, and 400 pounds.

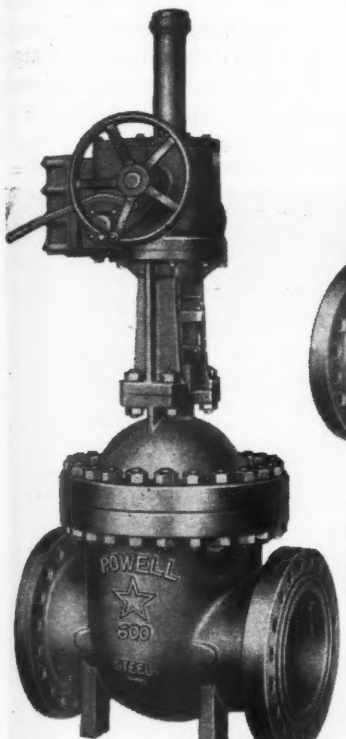

Fig. 6079 M.O. — Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Motor operated. Also available in Classes 150, 300, and 400 pounds.

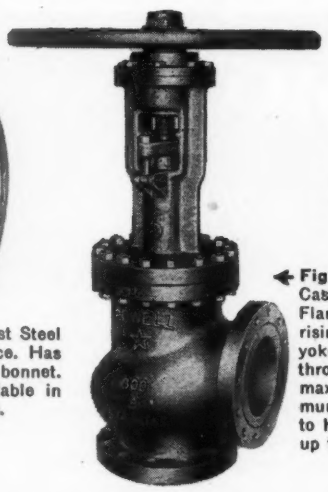

Fig. 1375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze seat rings and disc.

← Fig. 3033 — Class 300-pound Cast Alloy Steel Angle Valve. Flanged ends, outside screw rising stem, bolted flanged yoke. Streamlined areas through the body assure maximum flow with minimum pressure drop. Built to handle temperatures up to 1400F.

Fig. 1793 — Large 125-pound Iron Body Bronze Mounted Gate Valve. Flanged ends, bolted flanged yoke, outside screw rising stem and tapered solid wedge. Also available in All Iron.

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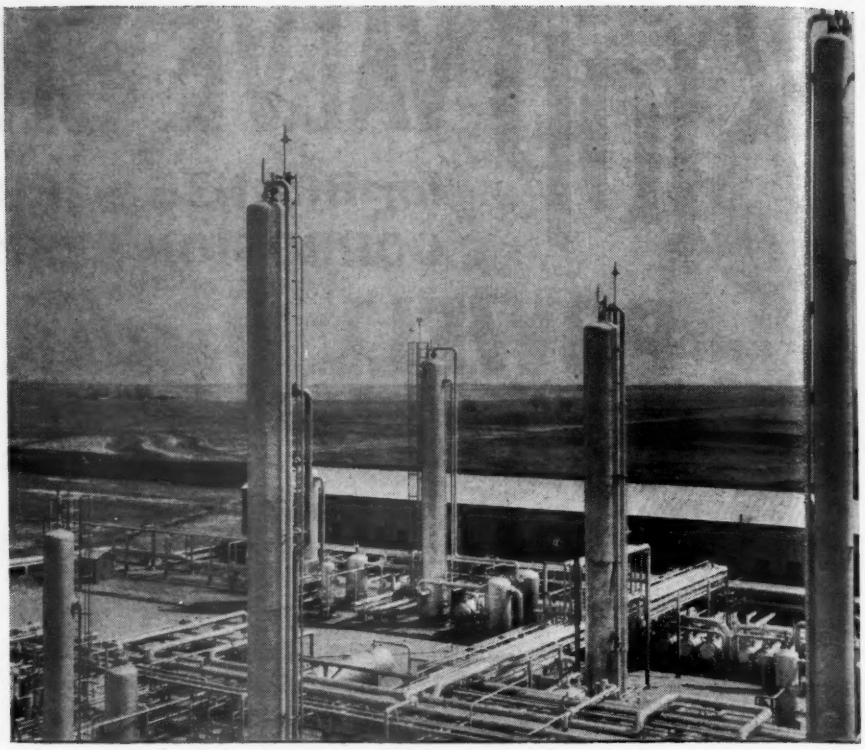

Gasoline plant in Levelland field.

Stanolind Opens Levelland Plant

The Levelland, Texas, gasoline plant, operated by Stanolind Oil and Gas Company as a gas conservation project, was formally opened recently. Designed and built to help conserve the natural resources of Texas, the plant will extract many valuable products from casinghead gas that could not be recovered in any other way. Butane, propane, and natural gasoline are extracted from the gas, then these products and the residue gas are sold for residential and commercial use. At the Levelland plant the residue will be sold to the El Paso Natural Gas Company for transmission to metropolitan areas.

The plant is situated near the middle of the Levelland field in the center of Hockley County. Gas for processing is taken from some 890 wells in the field. It is designed with a capacity of 40,000,000 cu ft and a recovery of 130,000 gal daily. Plant officials include Mitt Dowlen, plant superintendent; G. A. Ayling, plant foreman; R. N. Hall, plant engineer; and R. A. Sawyer, plant clerk.

Pennzoil to Build Unit

The Pennzoil Company has awarded to The M. W. Kellogg Company, refinery and chemical engineers of Jersey City, New Jersey, the contract for a propane-deresining and resin-fractionating unit at its present lube oil plant at Rouseville, Pennsylvania. The unit will be designed to charge 1370 bbl of Pennsylvania reduced crude each day, and is scheduled for completion late this year.

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—PERSONALS—

T. G. Hughes was elected president of Oronite Chemical Company, chemical products subsidiary of Standard Oil Company of California, to succeed **George L. Parkhurst,** who was elected chairman of Oronite's board of directors. Hughes, who joined California Standard in 1926, has been with Oronite since its formation in 1943, and has been executive vice president for the last year. Parkhurst replaces **R. G. Follis,** California Standard's board chairman, who remains as a director of Oronite.

Harry T. Klein, president of The Texas Company, was given the honorary degree of Doctor of Commercial Science by New York University recently. The presentation of the honorary doctorate to Colonel Klein and 49 other business and financial leaders climaxed a two-day conference marking the fiftieth anniversary of New York University's school of commerce, accounts, and finance.

Klein joined The Texas Company in New York in 1921 as assistant general counsel. In 1933 he was elected a director and vice president of the company, and was named president on April 25, 1944.

James H. Curtis has been appointed manager of manufacturing of the General Petroleum Corporation. This is the second advancement in 14 months for Curtis who has been manager of refineries for General Petroleum since February 1949. Previous to that he had been in charge of the Torrance (California) refinery.

James H. Curtis

Curtis, who came to General Petroleum in 1942 from the Lummus Company, became assistant manager at Torrance in 1944 and manager in 1945. He is a graduate of the University of Michigan.

Richard E. Lauterbach has been named assistant manager of General Petroleum's Torrance refinery according to A. E. Thompson, manager of the refinery. In addition, Thompson revealed that **Paul Sanders** has been advanced to the post of general superintendent of the refinery.

Sanders, a veteran of nearly 31 years service with General Petroleum, has been refinery superintendent since 1945. Lauterbach joined General Petroleum in 1936 as a laboratory assistant, and became a chemical engineer in 1939.

Paul Truesdell, a pioneer in the fields of oil industry reporting, advertising, and public relations, retired recently from active duty with Universal Oil Products Company of Chicago, Illinois. Mr. and Mrs. Truesdell are making their home in Napoleon, Ohio.

Rounding out 42 years in these fields, Truesdell is well known in the oil and gas industries, especially as a reporter of industry developments. Beginning his newspaper career with the *Cleveland Plain Dealer* in 1908, Paul joined the old *National Petroleum News* staff in 1917, before oil cracking had been thought of by many persons in the industry. For 12 years he reported advances in the rapidly-growing industry with a watchful eye on its problems, troubles, and controversies. In 1929 he was added to the staff of Universal, a fast-growing research, development, and service organization, with which he remained until his retirement. In honor of his long service to and with the press he was entertained at a luncheon given him in Chicago at the Union League Club by a group of company associates and friends and members of the Chicago press.

Paul Truesdell

Donald L. Katz

Dr. Donald L. Katz received the Hanlon Award from the Natural Gasoline Association of America at the Association's 29th annual meeting in Ft. Worth, Texas. He is the fourteenth recipient of the award. He is professor of chemical engineering at the University of Michigan, Ann Arbor.

The presentation of the award was made by James E. Pew, of Sun Oil and NGAA president. Pew referred to the outstanding work on retrograde condensation, phase behavior of hydrocarbons, and analogous problems, which Katz has carried out during the last 15 years, and stated that "his basic information on hydrocarbons has guided engineers in the design and operation of plants, not only because of its reliability but because it was always presented in a manner readily understood."

"There are few people in this room," said President Pew in making the award, "who have not been influenced or guided by the work of this man."

A Michigander by birth, Katz received his BS degree in chemical engineering from Michigan in 1931 and the PhD from the same school in 1934. After industry research experience with Phillips Petroleum Company he went back to Ann Arbor in 1936 as assistant professor. His industrial experience brought him into close contact with G. G. Oberfell, R. C. Alden, and other pioneers and leaders in light hydrocarbon research. He was made a full professor at Michigan in 1943. Katz has directed research problems for the NGAA in the solution of such problems as methods of sampling light hydrocarbon streams and others.

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HOUSTON . . . . NEW ORLEANS.

Charles Wirth III, du Pont Petroleum Chemicals Division, has been named Eastern district manager of the division. He was formerly Mid-Continent district manager in Tulsa, Oklahoma, where he organized the office and petroleum service laboratories during 1947. At the end of that year, du Pont began marketing its Tetraethyl lead compounds directly to the petroleum industry.

Charles Wirth III Charles D. Towery

Following graduation from Tulane with an MS degree in organic chemistry, Wirth was employed by Gulf Oil Corporation and Universal Oil Products prior to joining the du Pont Petroleum Chemicals Division.

Charles D. Towery, service representative in the Gulf Coast district, has been appointed Mid-Continent district manager succeeding Wirth. Towery is a graduate of Texas A & M, and formerly worked with the Gulf Oil Corporation and Pure Oil Company, and Bethlehem Supply Company prior to joining du Pont in 1947.

J. H. Olehy, Continental Oil Company, has been appointed regional manufacturing manager, southern region, with headquarters in Houston, Texas. An employee of Continental since 1927, Olehy is a graduate of the University of Colorado. **L. W. Vickery,** appointed manager of the engineering department, will replace Olehy. A graduate of Southwestern College, Winfield, Kansas, and Massachusetts Institute of Technology, Vickery became regional refinery superintendent of the southern region in 1949. He has been with Continental since 1929. **J. S. Hume,** who has been with Continental for 25 years, was promoted to director of technical services. He is a graduate of the University of Oklahoma. All appointments are effective July 1.

H. R. Wall was promoted to assistant superintendent in the Ponca City, Oklahoma refinery. In his new position, which he will begin June 1, Wall will be in charge of lubricating and light oil divisions. A University of Colorado graduate, he joined Continental in 1935. **J. M. Jones** will become superintendent of the company's refinery at Lake Charles, Louisiana on May 1. Appointed refinery superintendent in 1946, he began his career with Continental in 1926. He is a graduate of Johns Hopkins University.

Dr. M. R. Schmidt, general superintendent of the Standard Oil Company (Indiana), Whiting (Indiana), refinery retired recently after more than 32 years with the company. Joining Standard in 1917, Schmidt became general superintendent of the Whiting refinery in 1943. He will be succeeded by **A. F. Endres** assistant general superintendent. Endres, a graduate of the University of Illinois, joined the company in 1929, advancing to assistant general superintendent of the refinery in 1946.

P. C. Livesay, superintendent of the projects division will succeed Endres. He is a graduate of Texas A&M, joining the company in 1937. **Dr. Ford H. Blunck,** assistant superintendent of the light oils division, will replace Livesay. Blunck joined Standard in 1936 as a chemist in the research department. He is a graduate of the University of Illinois and Northwestern University.

William F. Brown, general foreman in the lubricating oil division of Continental Oil Company's Ponca City, Oklahoma refinery, has been selected as one of 14 young men from American industry to be awarded a 1950-51 Sloan Fellowship at Massachusetts Institute of Technology, Cambridge, Massachusetts.

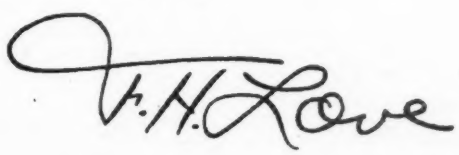
William F. Brown

Brown, who was graduated from Tulsa University, was selected as one of the 14 young industrial executives to participate in the fellowship program of study in business administration and economics, the course extending from June of this year to June, 1951. Established by The Alfred P. Sloan Foundation, Inc., the Sloan Fellowship Program For Executive Development was founded for young men in industry who have outstanding records of achievement.

Transmission Section of SGA

AT the recent annual meeting of the Southern Gas Association in Galveston the Transmission Section held its first session as a separate and distinct group. This marked an important addition to the activities of an association whose growth has been outstanding during the last few years. Two afternoons were devoted to programs of the section and the degree of interest was attested by the number present and the caliber of the men who participated. Those actively on the program included E. R. Cunningham of Texas Eastern Transmission Corporation, Paul Kayser of El Paso Natural Gas Company, Carl E. Cloud of Oklahoma Natural Gas Company, Frank S. Kelly, Jr., of Louisiana Natural Gas Corporation, J. W. Polkinghorn of Texas Gas Transmission Corporation, W. R. Gignilliat of Transcontinental Gas Pipe Line Corporation, E. W. Armstrong of Transcontinental Gas, Earl Kightlinger of Alabama Tennessee Natural Gas Company, George T. Ross of Houston Natural Gas Corporation, W. A. Broom of Arkansas Louisiana Gas Company, L. N. Brown of Southern Natural Gas Company, E. S. Murray of Tennessee Gas Transmission Company, James C. Reid of Southern Union Gas Company, J. J. King of Tennessee Gas, E. Maurice Myers of Consolidated Gas Utilities Corporation, Thos. B. Kelley of Texas Eastern, R. H. Johnson of Arkansas Louisiana Gas, H. G. Pegues of United Gas Pipe Line Company, L. C. Bomar of Southern Natural, Thomas S. Bacon of Lone Star Gas Company, A. L. Yauger of United Gas, Mills Cox of Texas Eastern, W. L. Stanton of Texas Gas, and I. I. Gardescu of Transcontinental Gas. Additionally, many prominent transmission men participated in discussions from the floor.

Carl Cloud, who traced the growth of the section, pointed out that SGA members began discussing the desirability of a separate Transmission Section as early as 1942. From this unconsolidated talk a meeting finally was held during the annual convention in Biloxi in 1947. The idea meeting with approval, and after subsequent discussions, the transmission group came into existence but functioned initially as a part of the General Operating Group. From it all, however, evolved the Transmission Section as a separate entity. From the enthusiasm displayed at Galveston there seems little question that the body will go on to greater things. As an indication is the fact that already a series of group meetings have been scheduled for the coming year. One meeting will be concerned with pipe line rights-of-way, another with compressor problems, others with operating and maintenance problems, dispatching, etc. Such meetings will provide an opportunity for the study and discussion of specific problems and will greatly extend the scope of the Transmission Section and its service to the industry.



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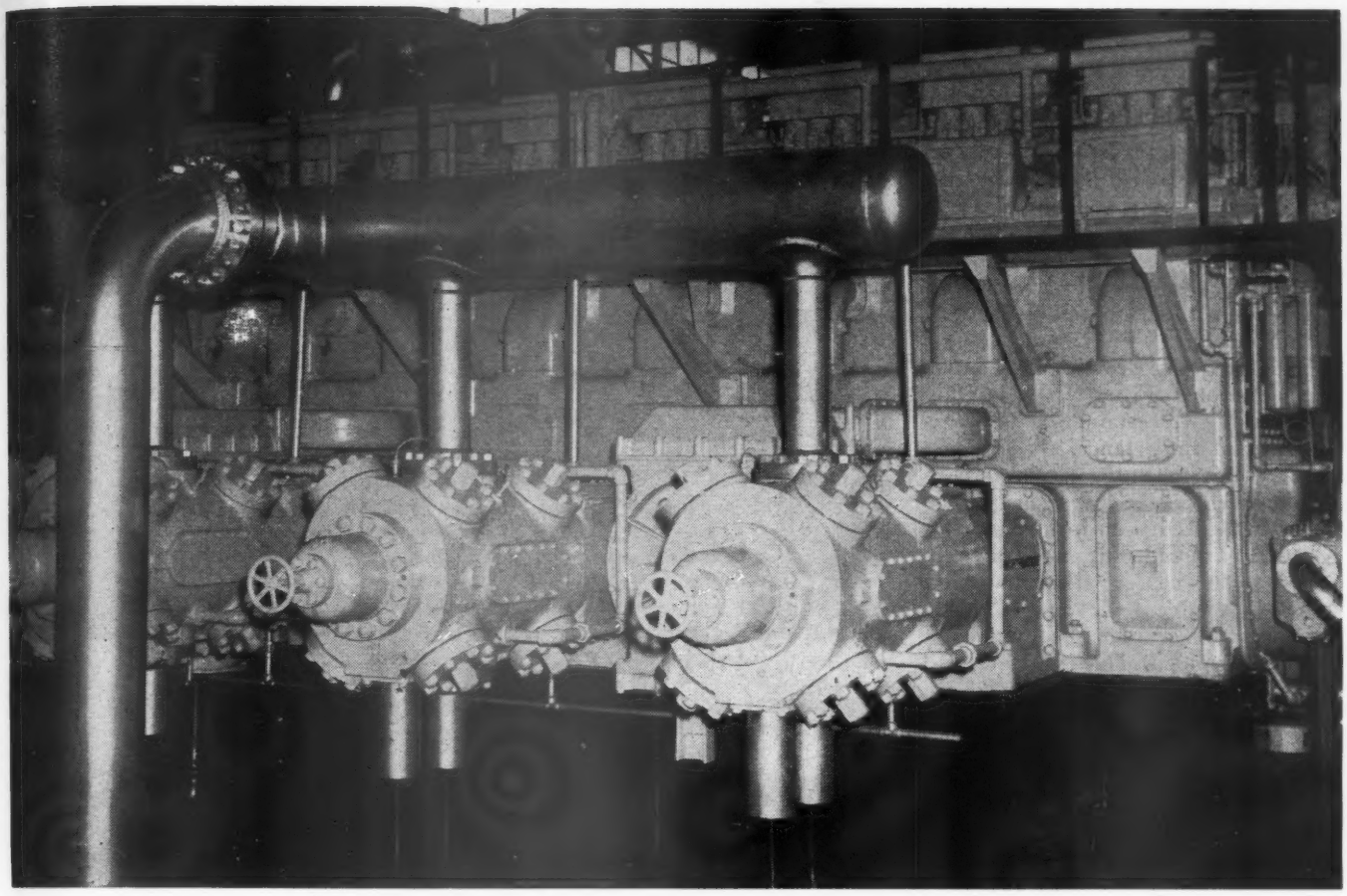


Close-up of gas compressor and scavenging compressor side view of engine.

Gas Compressor of New Design

Through Scavenging as Opposed to Loop Is Main Feature Of Machine Developed by Seven-Year Research Program

FRANK H. LOVE†

AN angle-type gas engine compressor of new design* has been installed at the Monroe, Louisiana, station of Tennessee Gas Transmission Company. The first, and to date only, unit of its kind to be put into service, the development is the culmination of a research program based on the Kadenacy patents and extending over a period of seven years. The equipment features through scavenging as opposed to loop scavenging. This type of scavenging, although not new or untried, generally speaking, is new insofar as its application to pipe line service is concerned.

In through scavenging as used by Worthington air enters through ports extending around the entire circumference of the lower end of the cylinder and the exhaust is through valves in the cylinder head. In the design under discussion, both the inlet port area and the exhaust area are of increased size, permitting the passage of greater volumes of scavenging air and resulting in lower scavenging air pressure. Because exhaust is through cam-operated valves, its opening and closing can be arranged at the optimum point with relation to the inlet opening and closing. This permits an earlier exhaust opening and results in greater exhaust area for blow-down before

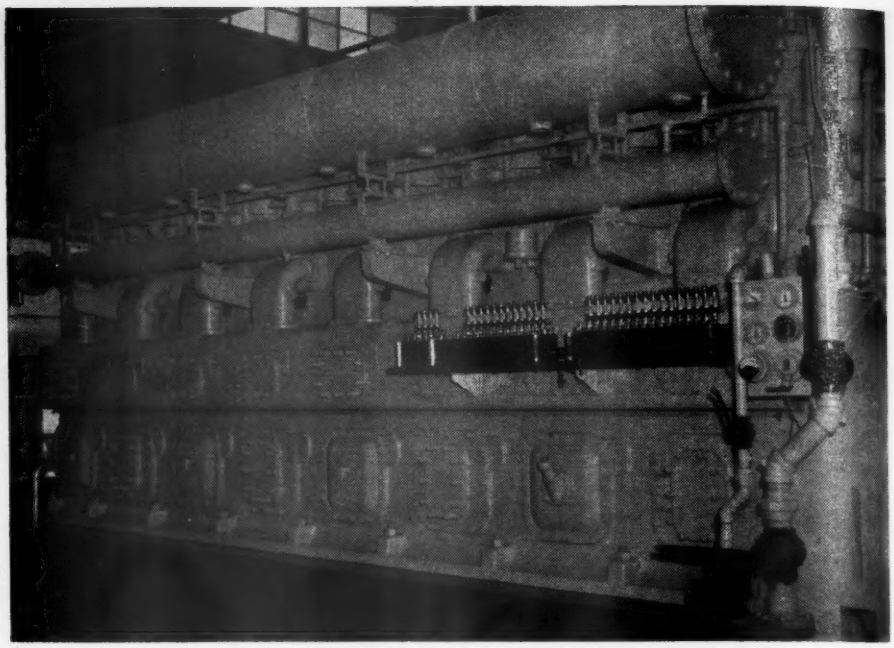
*Uniflo Type UTC-16 by Worthington Pump and Machinery Corporation. Covered by United States and foreign patents.

†Editor, Oil and Gas Pipelining.

EXCLUSIVE

the intake ports are uncovered, in this manner facilitating removal of the products of combustion. Again, on the closing side of the exhaust the cam-controlled valves permit earlier closing and effect appreciable supercharging. The increased blow-down, the supercharging, and the flow of air in a straight line result in charging the cylinders with a greater weight of air so that a higher mean pressure can be developed without increasing the temperature.

The foregoing are thermodynamic considerations. From an operating point of view, certain other factors also are of importance. As the inlet ports occupy the entire circumference of the cylinder, the lower part of the cylinder is at the uniform low temperature of the inlet air and is not subjected to the heat of the exhaust on one side and cool air on the other. Carbonization of oil on the lower ports are thus avoided. The cylinder head and the upper end of the cylinder are subjected only to the normal heat of 2-cycle engine, reduced by the system of through scavenging.



View of exhaust, fuel gas, and air manifolds. A duplicate air manifold is also on opposite side of engine.

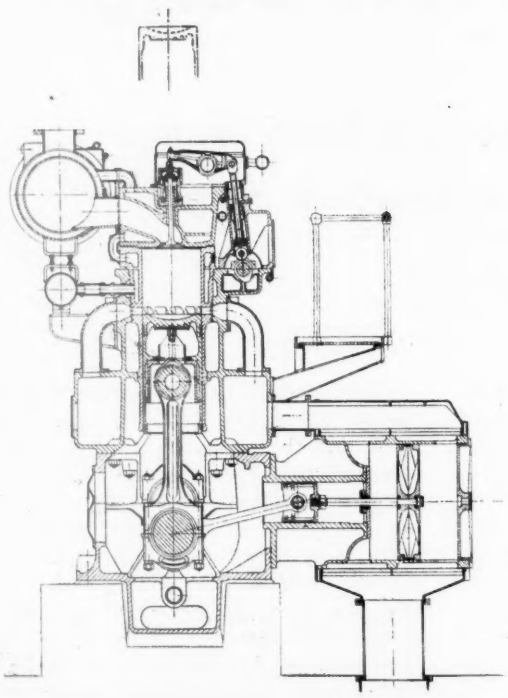
Mechanical Design

The general arrangement of the new compressor unit consists of vertical-in-line power cylinders and crosshead type compressor attached horizontally.

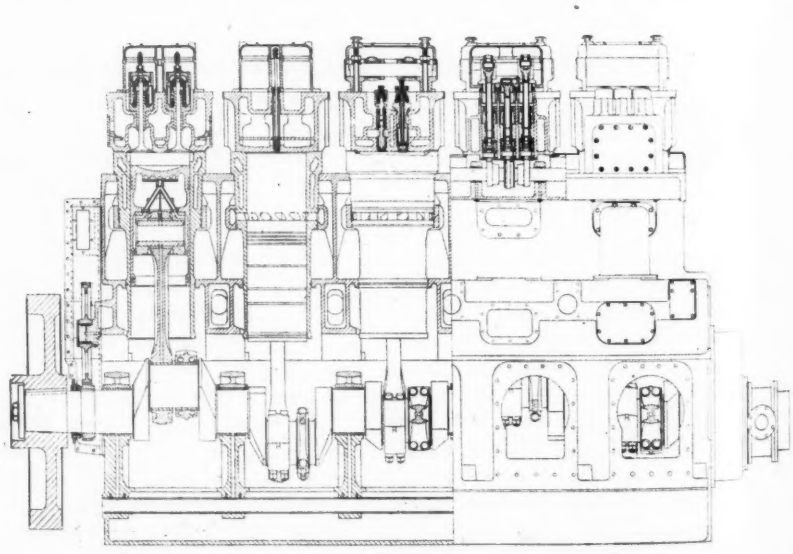
The main frame and base are each in one piece, extending the length of the engine. As the inlet ports extend entirely around the cylinder, both sides of the main frame are available for scavenging air reservoir space of large volume, resulting in increased steadiness of air flow.

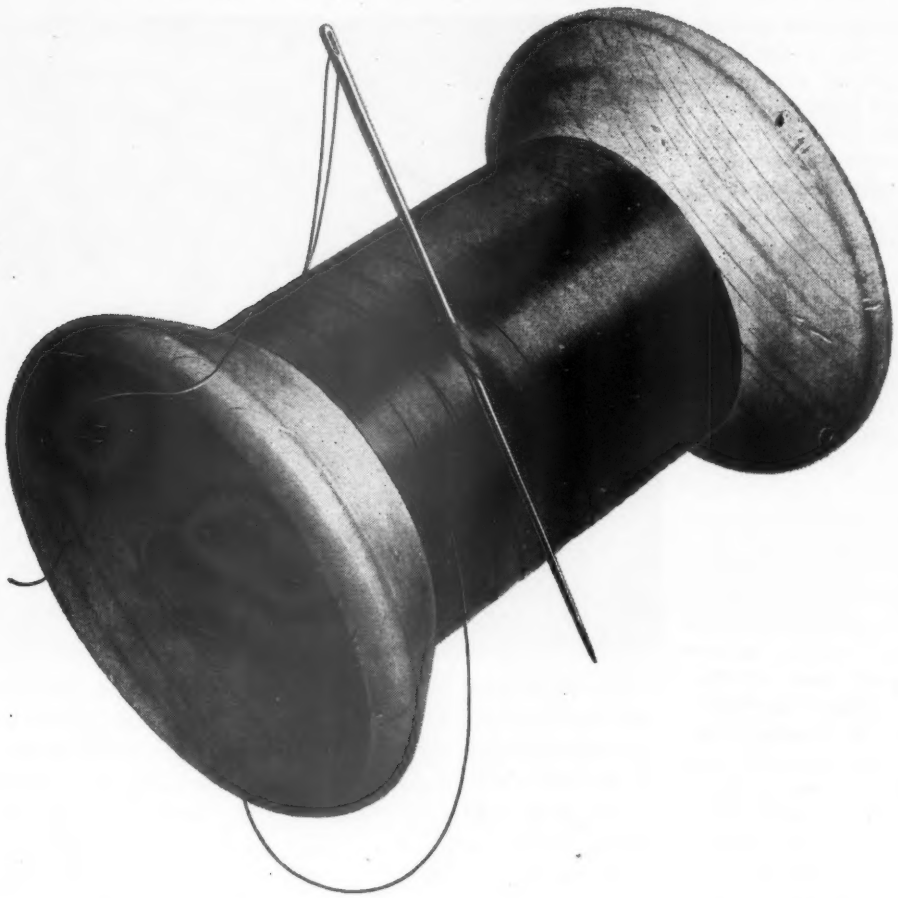
Construction of the main frame is such that removable cylinder liners can be used instead of separate cylinders, and the cylinder water jacket is cast integral with the liner. Because of the low temperature at the bottom end of the cylinder, water cooling is not required below the inlet ports. Therefore the jacket water space can be entirely enclosed in the casting without there being a joint to pack and seal from the crankcase. A partition near

Transverse cross-section of Worthington UTC-16.



Longitudinal cross-section of gas engine compressor.





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Electric Resistance and Fusion Weld—Plain End	8⅝" to 22" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	24" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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the top forces the cooling water around the entire circumference of the liner at high velocity, giving maximum cooling. The only packing required on the liner-to-frame fits is at the ports to prevent the low pressure scavenging air from escaping and at the lower fit to prevent the escape of oil splash.

Certain changes also have been made in piston design. The wrist pin is carried in a separate piece bolted to a transverse wall in the piston. This results in an unbroken outer piston wall and the elimination of strain caused by wrist pin fit. The absence of holes in the piston wall also improves heat flow and avoids unequal heat stresses. In oil-cooling the piston, oil is forced through an annular space between the wrist pin carrier and the outer wall to a series of circular grooves on the under side of the piston head. From there it is ejected through a series of radial slots in a fine spray against the inner wall back of the piston rings. An annular partition maintains an oil level at a point just below the bottom ring, and this oil prevents carbonizing after the engine is stopped. From a point below the wrist pin to the top of the piston there is an almost unbroken volume of flowing oil in contact with the inner wall.

In each head there are two exhaust valves, driven by separate rocker arms. The valve mechanism is equipped with hydraulic lifters, which eliminate valve tappet clearance. The valve gear, camshaft, and spur gear camshaft drive are of the 4-cycle type, and the valve gear is completely force feed lubricated.

The power cylinder head is of cone design and efficient cooling is obtained by proper direction of the water flow. The joint between the head and the cylinder is metal-to-metal. Connecting rods are interchangeable between engine and compressor cylinders. The rods are rifle-drilled to carry lubricating oil to the wrist pins and crosshead pins. The crankshaft is a one-piece steel forging with oil passages drilled for force feed lubrication of bearings.

Main bearings consist of concentric steel top and bottom shells, horizontally split and lined with babbitt. Cylindrical bottom boxes may be rolled out for inspection without disconnecting the oil piping. All main bearings are interchangeable, except scavenging pump end bearings.

Compressor cylinders are designed for the low compression ratios used on gas pipe lines. To obtain high efficiency with the low compression ratios, large valve and gas passage area is provided. Compressor piston rings are of the snap-ring type.

Taken at Monroe, Louisiana, station of Tennessee Gas Transmission Company during demonstration of Worthington Pump and Machinery Corporation's new gas engine compressor. Front row, left to right: Frank Gault, sales representative, A. M. Lockett Company, Lake Charles, Louisiana; H. A. Feldbush, vice president in charge of engineering, Worthington; Henry Lehn, consulting engineer, Buffalo Works, Worthington; John Talbot, assistant superintendent, compressor department, Tennessee Gas; G. W. Hammett, sales manager, Lockett, New Orleans; George Steven, executive engineer, Buffalo Works, Worthington. Back row: W. Worthington, engine specialist, Lockett, Houston, Texas; H. Barton, assistant to sales manager, engine division, Buffalo Works, Worthington; Bob Lockett, vice president in charge of sales, Lockett, New Orleans; Frank Carter, field engineer, Buffalo Works, Worthington; Fletcher Ferguson, superintendent of Monroe Station, Tennessee Gas.

Lubrication

All main, connecting rod, camshaft, and wrist pin bearings, and the valve gear, are pressure lubricated from a positive driven gear pump. Oil to the bearings passes through an oil cooler and strainer. A cast-in oil manifold provides protection against loose or broken connections. The main bearings may be removed without disconnecting any oil piping.

Engine and compressor cylinders and compressor stuffingboxes are oiled by a force feed lubricator driven from the camshaft.

Ignition System

The ignition is of the low-tension type, using a low-tension magneto to distribute the current to high-tension coils installed on each cylinder head adjacent to the spark plugs. Thus the high-tension wires are extremely short, and with the low-tension wires carried in a single conduit the system has a low fire hazard. The magneto is mounted on the forward end of the main frame and is driven by the camshaft through bevel gears.

Fuel System

Fuel gas is supplied to the engine at a pressure of 40 to 60 psi, depending on the quality of the gas. The governor operates on a gas throttle valve, varying, according to the load, the pressure in the gas header that supplies fuel gas to the inlet valves. The gas inlet valves are situated in the cylinder heads and are operated by push rods from the camshaft.

Safety Controls

In the interest of safety, shutdown controls are an essential part of the equipment. Three separate devices are included as standard equipment for protection of the engine. These devices will shut down the unit if (1) the engine overspeeds, (2) the lubricating oil system fails, or (3) the jacket water temperature becomes excessive.

* * *

A Method for the Determination of Glycol Concentrations in Water Solution*

J. A. PORTER and L. S. REID

THE widespread use of aqueous solutions of diethylene and triethylene glycol for the dehydration of natural gas introduces a number of design and operational problems in which the concentration of glycol in water solution is extremely important. The dew point depression obtained by passing natural gas in absorbing contact with glycol solution is a function of glycol concentration and, also, of the rate of circulation.

Boiling points of glycol-water solutions of various concentrations are reported in the literature[2] for barometric pressures of 760 mm Hg, but in many instances, stripping of the dilute solution is accomplished at pressures ranging as high as 15 psig in order to feed the concentrated solution to the circulation pump suction via the heat exchangers. Boiling points of these solutions are raised by the higher operating pressure, making it difficult to determine solution concentration in terms of reboiler temperatures. Another important design feature, which concerns concentration of the glycol solution, is viscosity which, in turn, affects pressure drop in transfer lines, heat exchangers, and the pumping characteristics at the various temperatures employed in the process.

In the past, usual practice has been to approximate the concentration of glycol-water solutions by means of specific gravity measurements made either by a hydrometer or a Westphal balance. The chance for error in a specific gravity measurement is large, particularly in view of the fact that the glycols are but slightly heavier than water. As a result, specific gravity figures should be used with caution, and only after proper temperature correction has been made.

Another method, used with some success on glycol-water solutions, is a chemical analysis involving oxidation of the glycol.[4] In addition to being slow, cumbersome, and exacting, this method is subject to error induced by solution of small quantities of petroleum hydrocarbon in the liquid glycol phase. This dissolved hydrocarbon is oxidized along with the glycol, appears as glycol in the analytical results, and indicates excessive glycol concentration.

As neither of the methods described above is entirely suitable, a third method was investigated, based on work originally proposed by Fried, Bigg, and Jennings,[1] who showed that the concentration of glycol in solution with water bears definite relationship to the viscosity of that solution. Accordingly, a method has been developed, an apparatus constructed and calibrated and a series of known and unknown samples have been run, indicating that the method is accurate, fast, and that the equipment involved is relatively inexpensive.

EXCLUSIVE

The apparatus employed consists of a constant temperature bath, a viscosimeter, a circulating pump, and sufficient rubber and glass tubing to connect the apparatus as shown in Fig. 1. The bath is agitated by means of a motor-driven stirrer, the water is circulated through the viscosimeter jacket by means of a small electrically driven centrifugal pump, and the bath temperature is held constant by means of two 500-watt immersion heaters actuated by a thermo switch and relay. A wiring diagram of the apparatus is shown in Fig. 2. Bath temperatures may be set at 25 or 30 C, depending on the room temperature and the water in this bath, maintained within limits of 0.05 C.

The viscosimeter consists of a 12-in. length of 7-mm bore glass tubing, one end of which has been heated and closed to about 0.2 mm. The viscosimeter tube has been etched with two marks spaced 6 in. apart and 3 in. from the ends of the tube. The tube is enclosed by a 20-mm diam glass

*This paper is based on a portion of the research done by Porter in partial fulfillment of the requirements for the MChE degree, University of Oklahoma, 1949.

THE AUTHORS

J. A. Porter received a B.S. degree in chemistry and chemical engineering from Texas College of Arts and Industries in 1947 and 1948, after serving three years in the U.S.A.A.F. As a graduate student in chemical engineering at the University of Oklahoma, he was awarded the American Gas Association Fellowship, and received the M.Ch.E. degree in 1949. He is associated with Black, Sivalls and Bryson, Inc., as process engineer.

J. A. Porter

Laurance S. Reid, professor of chemical engineering at the University of Oklahoma, was born in Ottumwa, Iowa. He attended Rice Institute and received a BS degree in chemical engineering from Iowa State College in 1931. After several years experience in the production and refining of petroleum, he completed requirements for the MS degree in chemical engineering at the University of Oklahoma.

L. S. Reid

Following his graduate studies he was associated with Phillips Petroleum Company engaged in research on secondary oil recovery methods and was later associated with Black, Sivalls and Bryson, Inc., as development engineer. From 1940 to 1943, Reid served as associate professor of chemical engineering at the University of Oklahoma and, from 1943 to 1945, he was associated with the Southern Natural Gas Company as assistant chief engineer. In 1945, he returned to the University of Oklahoma as professor of chemical engineering.

A specialist in natural gas processing, he is a member of the American Institute of chemical engineers and a member of the petroleum division of the American Institute of Mining and Metallurgical Engineers.

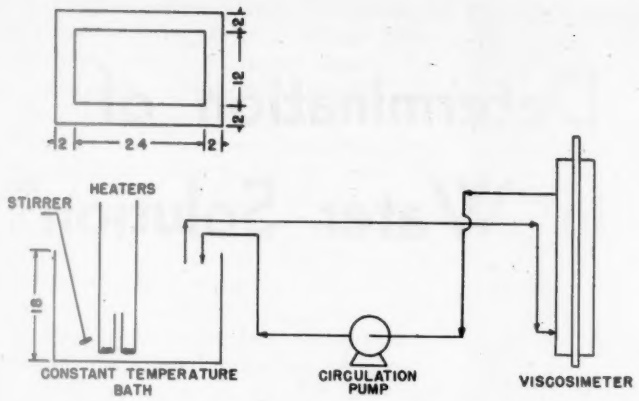

FIG. 1. Apparatus used in glycol determinations.

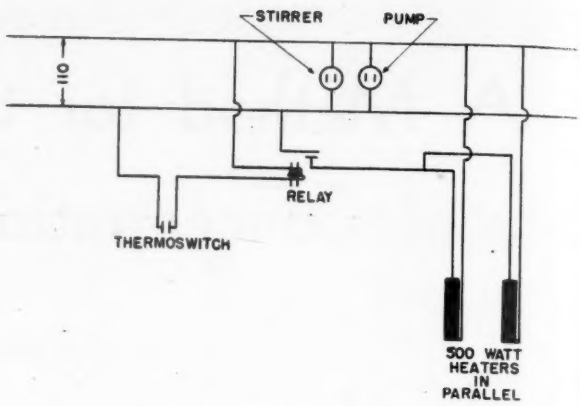

FIG. 2. Wiring diagram.

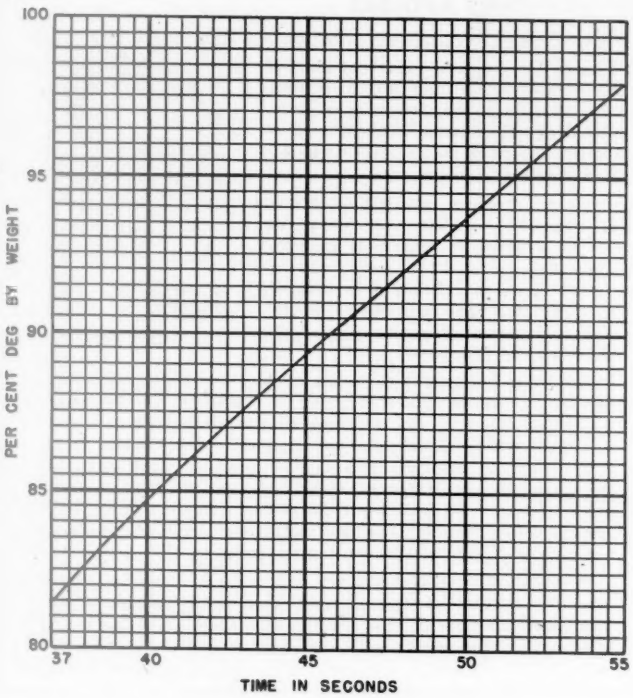

FIG. 3. Calibration curve for U. of O. orifice.

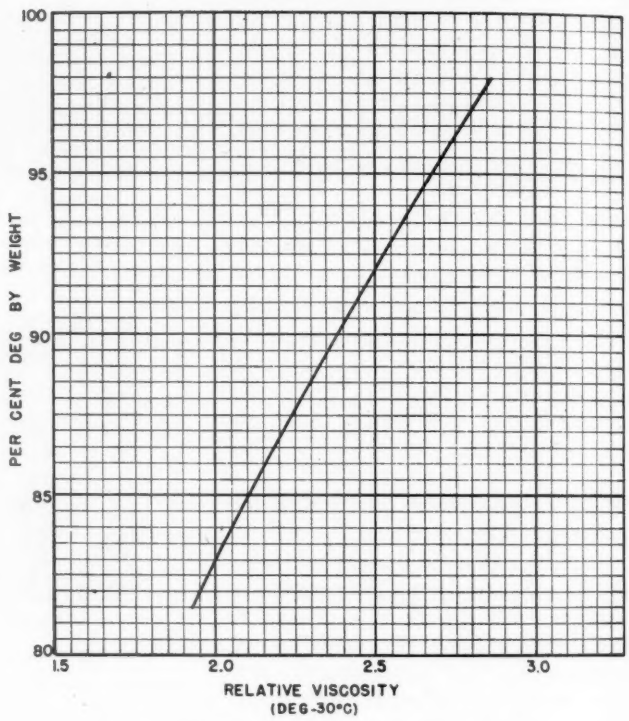

FIG. 5. Relative viscosity of DEG solutions.

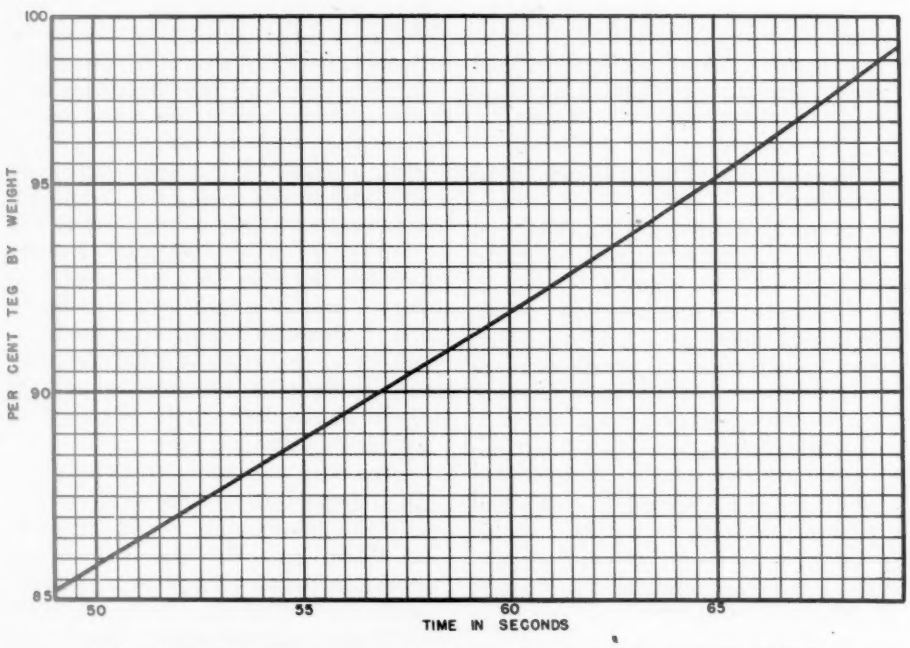

FIG. 4. Calibration curve for University of Oklahoma (TEG-30°C)

water jacket and secured by 2-hole rubber stoppers at each end so that water from the constant temperature bath may be circulated through the annular space.

The constant temperature bath was custom-built for this particular application and consists of ½-in. 5-ply wood outside, 16-gauge galvanized sheet iron inside, and 1½ in. of 85 per cent magnesium block insulation between the sheet iron liner and plywood case. All joints and corners of the sheet iron liner are soft-soldered. Dimensions are 28 in. by 16 in. by 18 in.

The cost and specifications of the component parts of the apparatus, excluding the bath proper, and of the glass and rubber tubing, are shown in Table I.

Experimental Procedure

The apparatus is assembled, as shown in Figs. 1 and 2, and made

TABLE 1.

Two 500-watt, 115-v, low lag-low, drift, knife type immersion heaters at $6 (Central Scientific Company)	$12.00
One 110-volt, ac-dc stirrer, Catalog No. 7605 (Palo-Myers Company, New York)	22.00
One thermoswitch, Catalog No. S-1610 (Fenwall, Incorporated, Ashland, Massachusetts)	8.40
One 110-volt a-c relay	5.00
One circulation pump, aircraft centrifugal type, war surplus	7.00
TOTAL	$54.40

ready for use by adjusting the bath temperature to, say, 30 C. Bottles containing samples of glycol-water solutions are immersed in the bath for a period of time adequate to bring the samples to bath temperature.

When all temperatures have come to equilibrium, a sample is selected and drawn into the viscosimeter tube by a suction tube. When ready, the suction is released and the time interval required for the meniscus to pass the two etched marks is determined by stop-watch and recorded. Four or five determinations are made on each sample and the average of the time intervals is used to determine the glycol concentration.

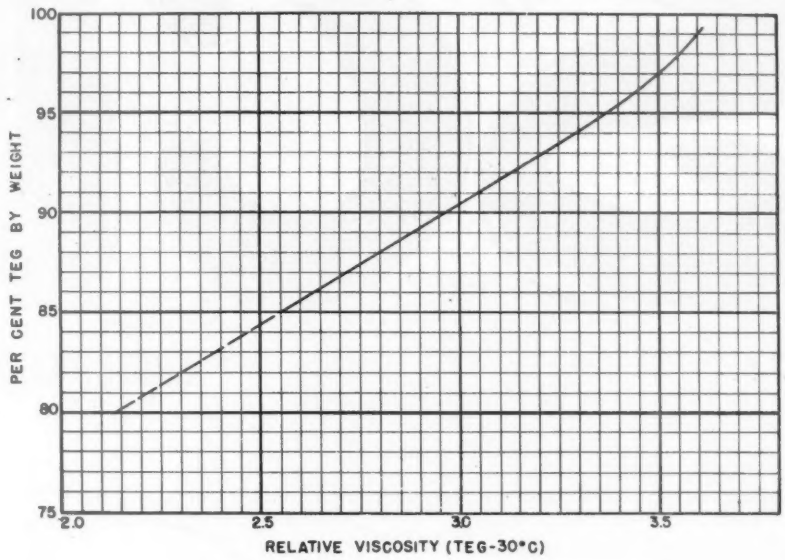

FIG. 6. Relative viscosity of TEG solutions.

Sample Preparation

Glycol solution samples obtained from high pressure gas dehydration units usually contain some solution gas that must be liberated before the viscosity determination is made. It has been found that solution gas can be removed by alternately shaking the sample bottle and removing the stopper after the sample has been warmed to bath temperature. Occasionally, these samples also contain small particles of rust, welding scale, carbonaceous material, and other solids in suspension. Samples must be filtered to remove these solids.

Viscosimeter Calibration

Each orifice must be calibrated prior to use. The orifice used in this investigation was calibrated by careful measurement of the time intervals required for the tube to pass glycol solutions of known concentrations. These samples were prepared by diluting pure diethylene—and triethylene glycol with distilled water. Results of these calibrations, conducted at 30 C, are shown in Figs. 3 and 4.

Any other orifice of the same character may be calibrated with ease, using plots of relative viscosity versus glycol concentration, shown in Figs. 5 and 6. Data for these plots were obtained by determining the time interval for the experimental viscosimeter, using distilled water at 30 C, and by dividing the time intervals for the various glycol solution concentrations, shown in Figs. 3 and 4, by the time interval for distilled water.

To calibrate a new orifice, it is only necessary to determine the time interval for distilled water. Then this time interval is multiplied by the relative viscosity of either glycol of various concentrations, as determined from Figs. 5 or 6. The data so obtained are used to plot a new calibration curve for the new orifice, similar to Figs. 3 and 4.

Availability of this relationship reduces the hazard of breakage or loss of a viscosimeter tube, and permits accurate calibration of additional viscosimeters without obtaining pure glycol samples and preparing and storing standard solution samples.

Discussion of Results

Experimental data indicate that glycol concentrations in a solution of either diethylene or triethylene glycol-water solutions can be determined with an accuracy of ± 0.5 per cent. Validity of the relative viscosity relationship has been established by calibrating new viscosimeter tubes and checking them against standard solution samples.

In making four or five check determinations of the time interval for one solution sample, it is necessary to immerse the sample container in a second container, supplied with water from the constant temperature bath, when room temperature differs appreciably from bath temperature.

The data obtained by this method are accurate when solutions of glycol and relatively pure water are employed. In some instances, where glycol solutions are employed in gas dehydration processes, the solution becomes contaminated with various inorganic salts, principally the chlorides of sodium, calcium, and magnesium. When the dilute solution is stripped, the salt concentration of the glycol solution is progressively increased. The effect of high salt concentrations on the viscosity of glycol-water solutions has not been investigated, but it is felt that data obtained by this method should be used with caution where this condition is known to exist.

Acknowledgment

Carbide and Carbon Chemicals Corporation provided the pure glycol samples and other pertinent viscosity data used in this investigation. This assistance is acknowledged with sincere thanks.

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1. Fried, S., Bigg, E., and Jennings, B. H., "A Simple Analytical Method for the Determination of Propylene and Triethylene Glycols," *Science*, *98*, 479; November 26, 1943.
2. Carbide and Carbon Chemicals Corporation, Bulletin "Glycols."
3. Porter, J. A., MChE Thesis, University of Oklahoma, August, 1949.
4. Russell, G. F., Reid, L. S., and Huntington, R. L., AIChE Transactions, p 317, 1945.

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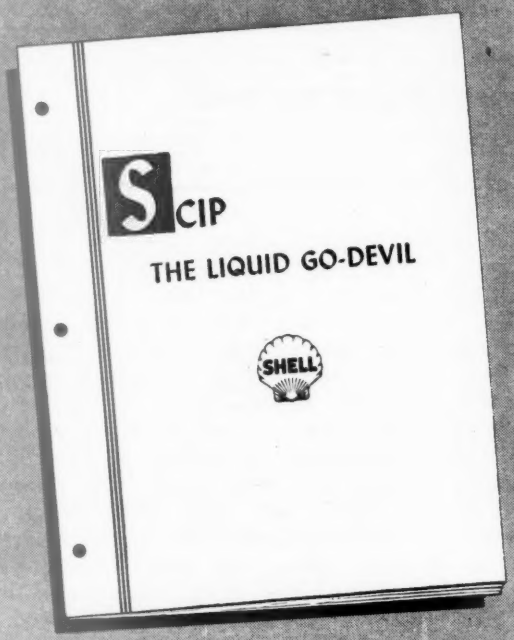

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Sections of 30-in. pipe being strung from anchor point near Qatif, along right-of-way of part of the Arabian American Oil Company's pipe line gathering system in Saudi Arabia.

Tapline at Halfway Mark*

Trans-Arabian pipe line project calls for gigantic civilian logistics operations

APPROXIMATELY half of the Trans-Arabian pipe line system, linking the producing oil fields of Saudi Arabia with offshore outlets in the Mediterranean, has been completed.

Most of the work done thus far has been at the eastern section, which includes 314 miles of the Arabian American Oil Company's gathering system. Completion of the entire system is expected early next year. Then 300,000 bbl of crude oil a day will be available at Sidon, some 30 miles south of Beirut on the Lebanese coast, saving a 3700-mile tanker haul around the Arabian Peninsula and through the Suez Canal.

The entire project has involved one of the greatest civilian logistical operations in history. Some 7000 separate kinds of items had to be planned for, purchased, and shipped six to nine months before being required at their destination points half way around the world. Construction camps and small cities have been erected on previously barren soil about as far from the sources of supply as it was possible to go.

The pipe itself presented unusual problems all the way from the fabrication plant to its placement in Arabian desert and over mountain ranges backing up the eastern end of the Mediterranean. Special machinery had to be installed for the rolling of the 30-31-in. pipe. A veritable bridge of ships had to be arranged to carry the pipe to the Middle East, for despite nesting of the 30-in. within the 31-in. pipe, only 20 miles of pipe could be carried on one ship. Some 6000 sailing days are involved in the delivery of all the pipe some 12,000 miles from its fabrication point. The final shipload needed to finish the job is expected to arrive in the Middle East in mid-1950.

The first field forces arrived in the early summer of 1947, and set up a small tent city toward the northern end of the Persian Gulf. The site chosen was a tiny sandy spit of land that the Saudi Arabs called Ras El Misha'ab. Despite a howling shamal, or Arabian sandstorm, the pioneers pegged down their tents and began the trundling of earth to water's edge for the start of a small jetty onto which supplies could be barged ashore.

Ras El Misha'ab had been chosen because it offered the best available distribution and access point to all parts of the eastern section of the pipe line-to-be. Access roads could fan out from this port so truck convoys could supply the isolated construction points with a minimum of travel — but minimum in the Middle East often means hundreds of miles.

Faced with an unloading problem that would run hundreds of tons a day, plans had been made to set up an aerial tramway from shore to a man-made island 2½ miles out in the Persian Gulf, for shallow water prevented large vessels approaching any closer. The same type of conveyance is used to haul Douglas firs out of the almost inaccessible forests of Oregon and Washington, and its adoption has proved most successful for the Persian Gulf pipe line deliveries.

Construction crews turned the handful of tents at Ras El Misha'ab into a bustling city within six months. Warehouses, shops, offices, a hospital, laundry, fresh water and sewerage systems, and a power plant, were in operation. Immense quantities of supplies were piling in, for almost everything needed for day-to-day existence as well as pipe line construction had to be brought from the United States.

By the spring of 1948 the Skyhook, as the aerial tramway was called, was in operation and man-operated cable cars were bringing in pipe at rates up to a thousand tons a day from the steel-piered sea island on which the freighters deposited their cargoes. Five hundred Americans and 1500 Saudi Arabs were backing up the survey and construction crews who spread out to build roads, decide on final routes, and start laying the line.

To ease the supply and communications job, a pioneer trail, later ex-

*Prepared by staff members of Trans-Arabian Pipe Line Company.

EXCLUSIVE

panded into a passable road, was blazed across country to Duwaid, approximately half way along the line. Line camp construction included complete living quarters, a communication and supply center, and an airstrip for use by planes up to the DC-3 size. Intervening points along the line are handled by ten mobile camps, each a complete unit, capable of being picked up and transported on trailers wherever needed.

The entire Trans-Arabian pipe line project, including that portion of the line in Aramco's gathering system, will require six pumping stations. Each station is being built as a complete living and working community.

Four pumping units in series powered by four 1710-hp diesels will do the basic pumping job. An additional pump and diesel engine will be available as a standby. Three generators driven by three 1320-hp diesels will provide power for the booster pumps and other electrical equipment. Fuel for the engines will be drawn directly from the pipe line and maintained in two fuel-oil storage tanks of 2000 bbl each. There will also be a 96,000-bbl crude equalization tank at each station.

Living and working quarters for the hundred Saudi Arabs and twenty-odd Americans at each station will consist of dining halls, car shelters, a communication center, garage, warehouse and shop, firehouse, field hospital, and adequate water tankage. A light plane landing strip will afford the stations quick availability in case it is necessary for supplies to be flown in, or an accident case flown out.

C. A. Swigart, vice president, B. E. Hull, president, and A. H. Horne, vice president, of the Trans-Arabian Pipe Line Company.

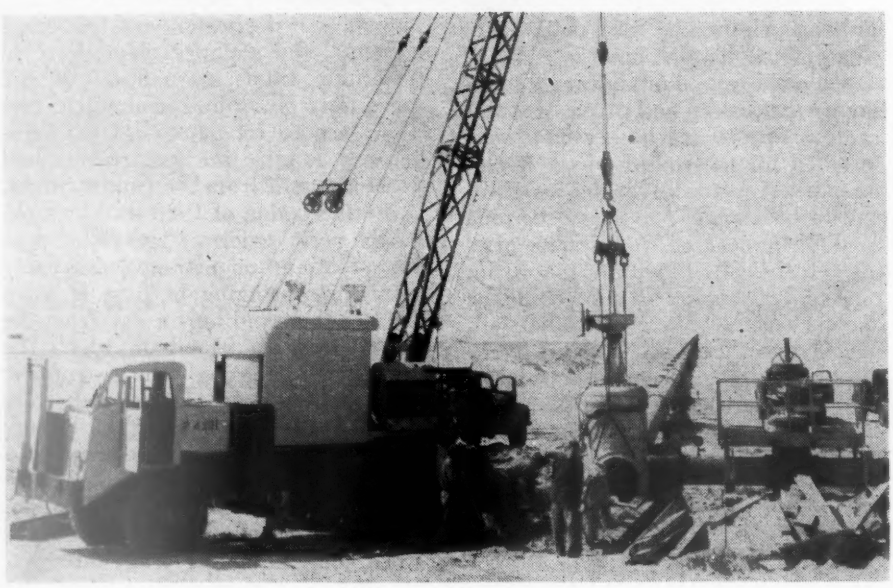
One of the sidelights to the pump station program has been the assistance rendered the migrating Saudi Arabs who are constantly searching for adequate water supplies for their herds of camels, sheep, goats, and donkeys. Each pump station has sunk its own water wells and a new string of "refueling" units has been strung along the barren Arabian peninsula. As many as 5000 animals have been seen at one of the watering troughs set up and connected to the pump station wells.

About two-thirds of the line is being laid underground and one-third above ground, the latter in a fully-restrained position. This process involves the elimination of expansion loops, and the laying of the pipe in mean temperatures on ring girders set into piles or piers. Under this arrangement the pipe itself withstands all contraction and expansion stresses. Wherever changes of direction involving more than 2 degrees are required, large steel H-beam piles are embedded in rock or concrete and provide a firm base. To date only 16 anchors like this have been needed.

The pipe is carried out of Ras El Misha'ab in 93-ft lengths, as three 31-ft sections are pre-welded at the port with automatic welding equipment. Huge 300-hp trucks, the biggest civilian motor units ever built, work in convoys and handle up to 40 tons of pipe per unit.

The basic hauling equipment, which is delivering a daily total approaching 150,000 ton-miles, consists of 133 tractors, flatracks, and trucks. Backing up these basic power units are more than 200 trailers, vans, and pipe dollies of various sizes, shapes and descriptions. Special reefer vans to carry frozen food have been designed, and are proving extremely practicable in supplying the construction crews with chilled and frozen products.

Setting an 11-ton main gate valve at the Qatif end of the 30-in. pipe line, a section of the Arabian American pipe line gathering system.



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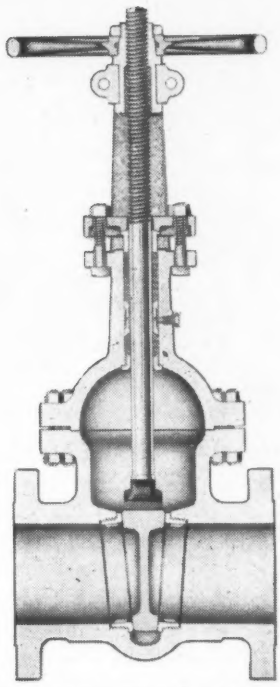

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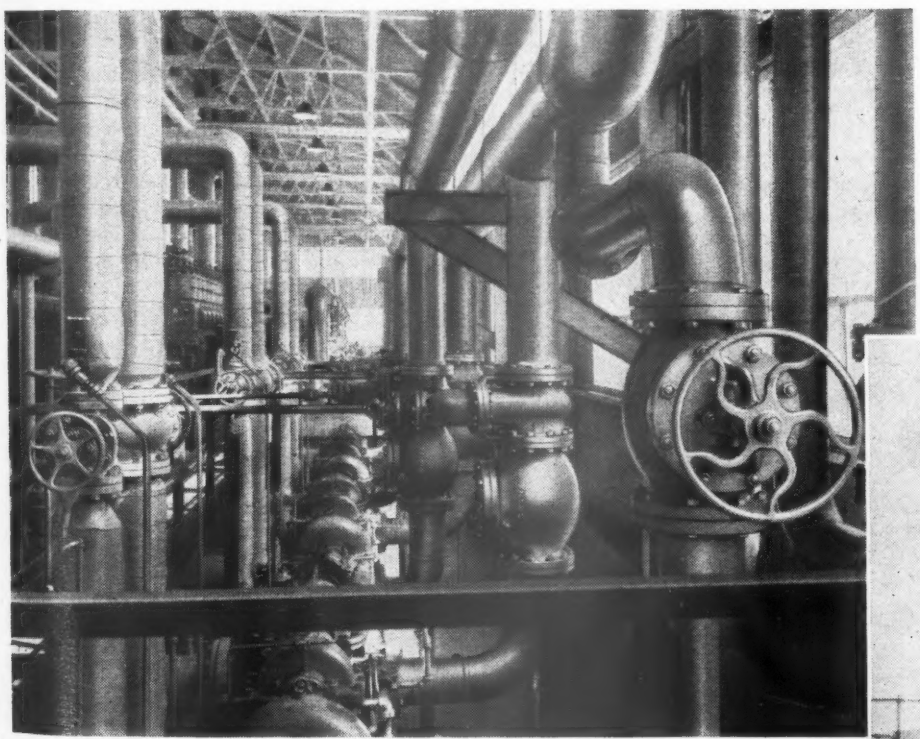

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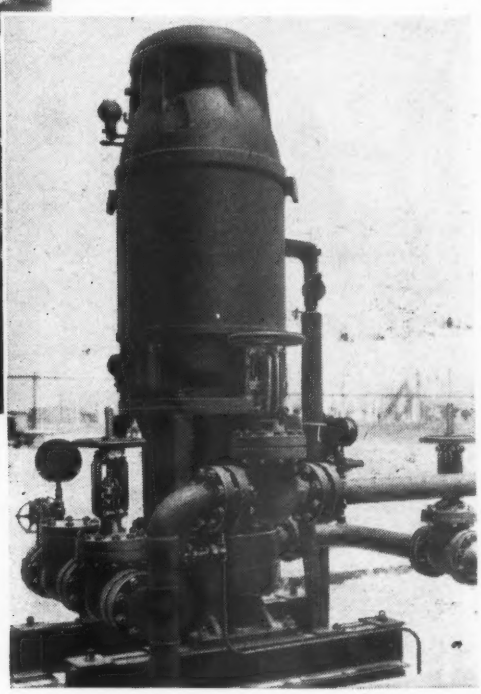

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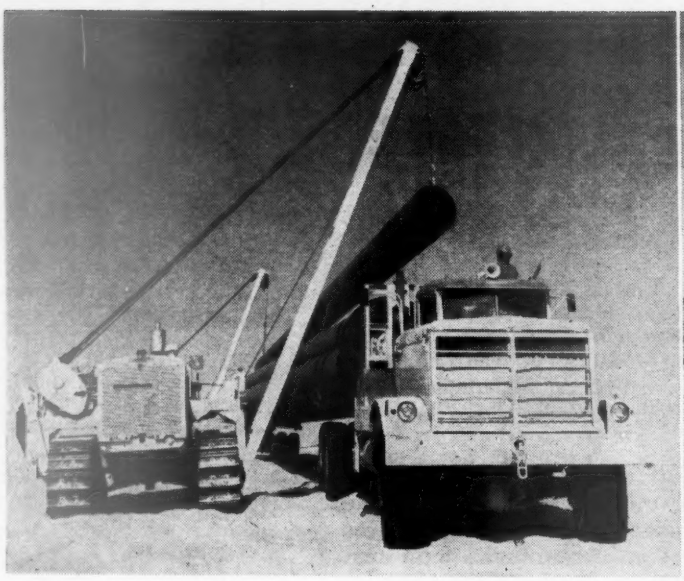


Ninety-three-foot pipe sections are unloaded from a trailer by a "side-boom" cat for stringing along the right-of-way of the Abqaiq-to-Qatif section.

Ditching machine at work on 30-in. pipe line right-of-way 10 miles south of Qatif, a part of the Arabian American pipe line gathering system.

The convoys can handle as much as a freight train of cargo, for there are no weight limitations on the desert plains. Trailer units often run to 50 tons, with much of the cargo consisting of road-building equipment and construction materials.

To expedite construction of the entire project, it was planned to start building from both the Persian Gulf and the Mediterranean ends. Two factors intervened to slow up this procedure. For several months the Department of Commerce held up badly-needed pipe shipments, delaying eastern construction plans, and the war in Palestine necessitated almost a complete shutdown of all activities on the western end. Survey crews had to be pulled out, construction crews returned to the States or shifted to other points, shipment of materials halted.

Now this has changed. Construction camps are being built in Syria and Lebanon, and the first pipe shipments have arrived in Beirut. Motor and construction equipment is being assembled at the terminal point of Sidon, where construction of a tank farm is being pushed. There will be an initial installation of 16 tanks with a capacity of 180,000 bbl each, at elevations of 285 to 378 ft above sea level and a mile to a mile and a quarter from tidewater.

Four submarine crude oil loading lines, two of 20-in. and two of 30-in. diam, will run about a half mile out to mooring stations, providing access in water 50 to 60 ft deep. Loading will be by gravity feed. Some auxiliary facilities will be required, including a communications system from ship to shore and shore to tank farm, and a small jetty for handling harbor launches and the necessary lighters.

President of the Trans-Arabian Pipe Line Company is Burt E. Hull. He is assisted by vice presidents Clyde A. Swigart and Al N. Horne, the latter heading the field force.

Construction of the eastern section is being done by International Bechtel, Inc., with George S. Colley, Jr., vice president, in charge. Williams Brothers Corporation of Tulsa is handling construction on the western section, and the Graver Construction Corporation is building the terminal tankage at Sidon, Lebanon, and one pump station in Saudi Arabia. * *

Sections of nested 30-in. and 31-in. pipe being unloaded at Beirut, Lebanon, field headquarters of the Trans-Arabian Pipe Line Company.

Orifice Meter Chart Calculation

W. F. MARTIN

MECHANICAL computation of values from orifice meter charts is the popular method of computation. The double line integrator enjoys a wide use, though it is an expensive instrument.

Observation has indicated that a small per cent of charts handled, perhaps 5 per cent, would require special handling if square root averages were used instead of the sum of instantaneous products of the differential and static pressures expressed in the square roots thereof.

When static pressures are constant, or almost constant, they can be read at a glance, and when square root orifice meter charts are used, the static reading is the one to be used in connection with the differential reading obtained by a single line integrator, or a square root planimeter. When regular charts are used, the equivalent for a square root chart reading for the static pressure read can be obtained from a convenient table. The table calculation is as follows:

Let:

a = gauge static pressure,

b = atmospheric pressure, and

c = static pressure range of meter or value of spring gauge in psi.

Then:

$$\left(\frac{a+b}{c}\right)^{1/2} \times 10 = \text{SR 10 chart reading.}$$

The multiplication by 10 is necessary because the conventional coefficient is based on 1 psi absolute static pressure and 1 in. differential pressure. The two ranges on chart are 100 each and $(100)^{1/2}$ is 10.

Example:

a = 232 psi

b = 13 psi

c = 500 psi

$$\left(\frac{232+13}{500}\right)^{1/2} = \left(\frac{245}{500}\right)^{1/2}$$

$$= (0.49)^{1/2} = 0.70$$

$0.70 \times 10 = 7.00 =$ SR 10 chart reading.

Meter static pressure pen setting:

When gauge pressure is desired, such pen is zeroed at chart zero.

When absolute pressure is desired such pen is zeroed at a point above chart zero a distance equivalent to atmospheric pressure in relation to the meter static pressure range, or the value of the spring gauge in psi.

Let x = distance representing atmospheric pressure for 500 psi spring,

Then x/2 = distance representing atmospheric pressure for 1000 psi spring,

And 2x = distance representing atmospheric pressure for 250 psi spring,

And 5x = distance representing atmospheric pressure for 100 psi spring.

Integrator static pressure pen setting:

When the chart undergoing computation has recorded thereon absolute static pressure, such pen is zeroed at chart zero.

When the chart undergoing computation has recorded thereon gauge static pressure, such pen is zeroed below chart zero at a point representing a distance equivalent to atmospheric pressure in relation to the static pressure range, or the value of spring gauge in psi, of the meter, from which the chart undergoing computation was removed.

Double line integrators must have a means of adjusting static pressure pens for the various pressure ranges of the charts that may be computed thereon, so long as charts have gauge pressures recorded thereon; however, the writer sees no good reason for continuing with gauge pressures.

Single Line Integrator (Martin-Warner I)

The primary purpose of this integrator is to arrive at the average square root value of the differential line of an orifice meter chart. As static pressure in the great majority of cases is constant, or nearly so, a machine computation of the differential line is all that is necessary. Even in the small minority of cases of variable static pressure, the chart can be broken up into segments, where average square roots will result in an accurate computation.

Quite a few people engaged in orifice meter chart work do not realize that where one line is constant, any variation in the other line will not adversely affect the computation. An example follows, taking square root chart readings and a 24-hr chart.

Absolute static pressure.....	7.00
Differential 6 hr.....	6.00
Differential 6 hr.....	4.00
Differential 6 hr.....	5.00
Differential 6 hr.....	8.00

Instantaneous calculation of a double line integrator will give the following:

$7 \times 6 \times 6 = 252$
$7 \times 6 \times 4 = 168$
$7 \times 6 \times 5 = 210$
$7 \times 6 \times 8 = 336$
Total . . 966

Average differential =

$$\frac{6+4+5+8}{4} = 5.75$$

$$7 \times 5.75 \times 24 = 966$$

The above should show conclusively that square root averages will give an accurate result if *one* line is constant or nearly so.

THE AUTHOR

W. F. Martin, born in Ashland, Kentucky, July 30, 1893, has had a number of vocations—railroading, commercial fishing, lumbering, soldiering, and active participation in the oil and gas industry since 1920. His first connection with petroleum was with Humble Oil and Refining Company at Baytown, Texas, in 1920. This followed service as an infantryman with the U. S. Army from 1917 to 1919. He was with the Empire Companies in Oklahoma and Kansas from 1920 to 1930, when he joined the staff of the Texoma Natural Gas Company. He is still with the latter company doing engineering and accounting work. His headquarters are Amarillo, Texas. Inventing and fishing are his hobbies.

EXCLUSIVE

The single line integrator above referred to cannot be used to average static pressure, when such static pressure is gauge pressure. The recorded static pressure must be absolute pressure before this integrator can be used to average it.

In the event it is desirable to use the Martin-Warner Integrator I to arrive at the average square root of the static pressure, where absolute static pressures are recorded on the chart, the following must be kept in mind:

The integrator is so designed that, when running a square root chart (SR 10 chart) that has been on the meter gauge for the full period (24 hr for a 24-hr chart) the number of revolutions made by the counter wheel will be equal to the value of the static pressure recording. For example, if the static pressure recording follows the 7 line all the way around, the average static pressure will be 7 and the counter wheel will have made exactly 7 revolutions when the chart has been run, and will therefore read 7. If the static pressure follows the 7 line half way around the chart, and the 6.90 line for the other half period, the average static pressure will be 6.95, and the counter wheel will have made 6.95 revolutions when the chart has been run, and will therefore read 6.95.

If the chart has not been on the meter gauge for the full period, then a time correction factor must be applied to the reading taken from the counter wheel after the chart has been run for the partial period to arrive at average static pressure. Assuming the chart was on the meter gauge for only 16 hr of the 24-hr period, then the reading from the counter wheel, after running the static pressure of the chart, would have to be multiplied by 24/16, or 1.5, to arrive at the average. Example follows: Static pressure follows the 7 line for 16 hr of the 24-hr period. It is removed from meter gauge at the end of 16 hr. The reading on the counter wheel on completion of the run will not be 7, but will be ⅔ of 7, or 4.667. This figure, $4.667 \times 1.5 = 7$, which is the average static pressure value. (The average differential value in the above case would be 4.667).

In the vast majority of cases, however, as mentioned before, no such machine averaging will be required; the static can be read with the eye at a glance.

Our thought in the matter is that a reasonably priced single line integrator, for the purposes outlined herein, is a real contribution to the oil and gas industry; that it puts machine computation of orifice meter charts within the reach of all.

M Factor

The SR 10 chart is a percentage chart, such percentages being expressed in the square roots thereof; however, the readings from the SR 10 chart are not exactly considered as square root percentages by the chart reader. $(0.49)^{1/2}$, being 0.70, is considered as 7.0 by the chart reader, and probably would not be recognized as a square root percentage by many chart readers. Because it is a percentage chart (100 in. differential pressure and 100 psi static pressure), when coefficients are prepared for differential and static ranges that differ from 100 in., 100 psi, and M Factor must be applied to such coefficient. It is arrived at as follows:

Let:

d = differential pressure range of meter,

e = static pressure range of meter,

f = product of differential and static pressure range on SR 10 chart (100 in. differential, 100 psi static), or 10,000.

$$\frac{(de)^{1/2}}{(f)} = \text{M Factor}$$

A few methods of chart computation follow:

24-hr regular chart: 50 in. differential 500 psi static.

Hourly coefficient = 2.0000

Atmospheric pressure, 13 psi

Differential reading = 24.5 in.

Static reading — gauge = 307 psi

307 + 13 = 320 psi = absolute static pressure.

$(24.5 \times 320)^{1/2} = (7840)^{1/2} = 88.54$ = pressure extension for 1 hr.

$88.54 \times 24 = 2125$ = pressure extension for 24 hr.

$2.0000 \times 2125 = 4250$ M cu ft = volume.

24 hr SR 10 chart — meter range 50 in. differential 500 psi static:

Hourly coefficient = 2.0000 (conventional)

d = 50 in.

e = 500 psi

f = 10,000

$$\frac{(50 \times 500)^{1/2}}{(10{,}000)} = 1.581 = \text{M Factor}$$

$2.0000 \times 1.581 = 3.1620$ = hourly coefficient for SR 10 chart

24.5 in. differential = 49 per cent of 50 in. $(.49)^{1/2} = 0.70$

320 psi static — 64 per cent of 500 psi $(0.64)^{1/2} = 0.80$

$0.70 \times 10 = 7.00$

$0.80 \times 10 = 8.00$

$7 \times 8 = 56$ = pressure extension for 1 hr

$56 \times 24 = 1344$ = pressure extension for 24 hr

$1344 \times 3.1620 = 4250$ M cu ft = volume.

Martin-Warner approach:

Full capacity of a 24 hr, 50 in. differential, 500 psi static chart with an hourly coefficient or 2.0000 is calculated as follows:

$(50 \times 500)^{1/2} = 158.1$

24-hr coefficient = $2 \times 24 = 48$.

$48 \times 158\text{-}1 = 7589$ M cu ft = coefficient.

Differential reading = 49 per cent $(0.49)^{1/2} = 0.70$

Static reading = 64 per cent $(0.64)^{1/2} = 0.80$

$0.70 \times 0.80 = 0.56$

56 per cent of 7589 = 4250 M cu ft = volume.

If one thinks of chart calculations as a square root percentage of the whole, there might be a better understanding of the job.

There is a difference between the square root planimeter manufactured by Foxboro and the Martin-Warner single line integrator. Inasmuch as the counter wheel of the Foxboro instrument is at various angles to a straight radial line during the course of the computation of the chart, the "planimeter run" must be stopped on the same concentric line of the chart at which the start was made. With the Martin-Warner instrument the stop is made at the end of the recorded line wherever it may be. This is because the counter wheel is at all times during calculation of the chart at right angles to a straight radial line of the chart.

There is no need to "figure" charts to the nearest 15 minutes with a square root planimeter or the single line integrator; they can be "figured" exactly.

The counter wheel should be zeroed before each "run" to obviate the necessity of a subtraction of the initial reading from the final reading, thus eliminating another chance for error.

At this point, it is believed desirable to set out mathematical explanations of various machine calculations.

Double Line Integrator with a means of introducing a coefficient:

All movements are in percentages.

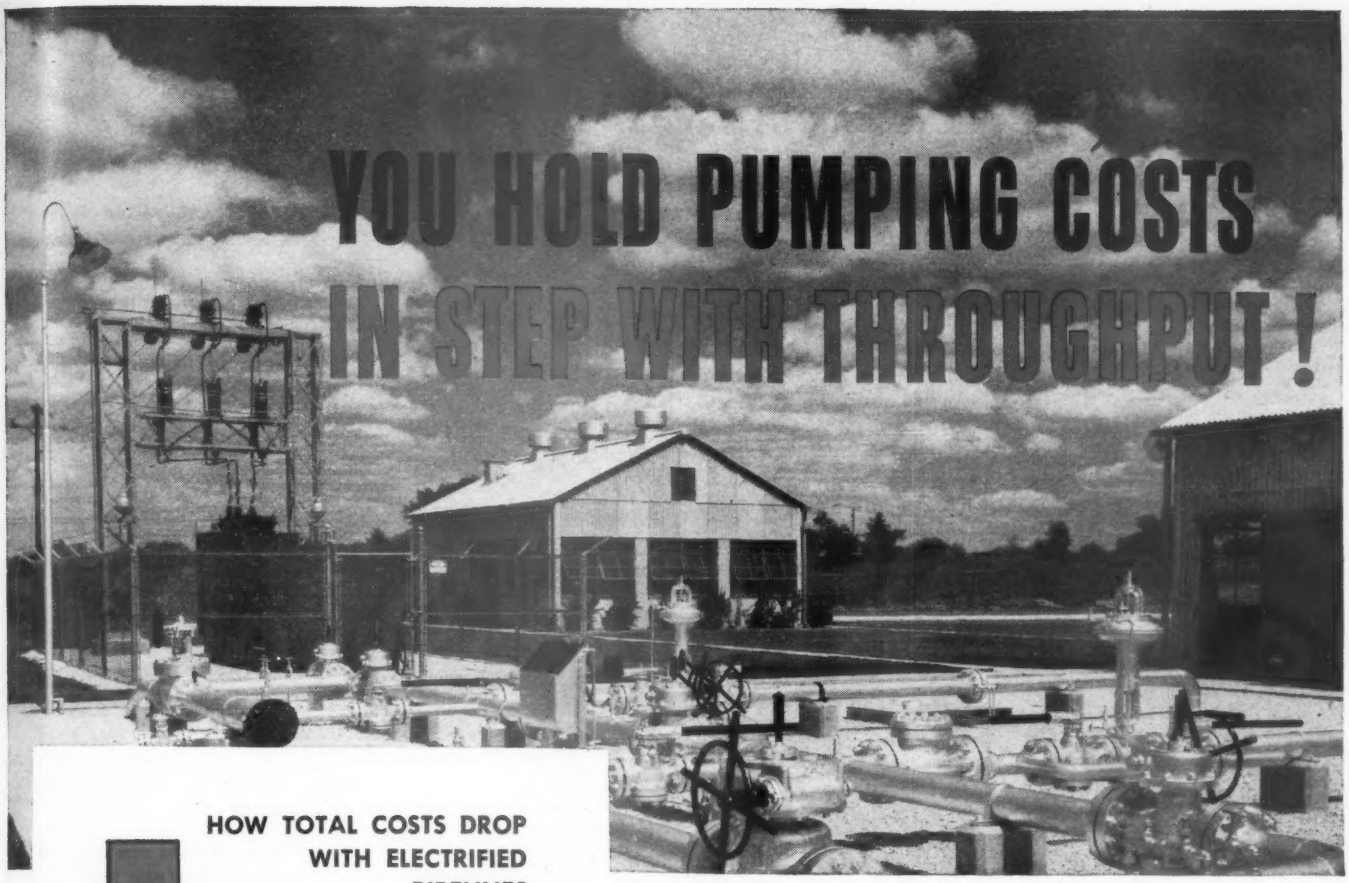
Static pressure side of machine:

a = machine movement,

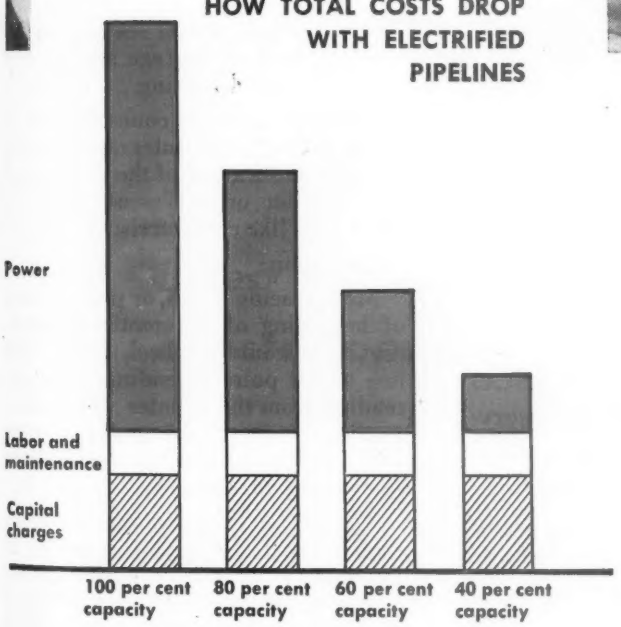
b = tracing pen radial movement $= a^2$,

k = constant.

Differential pressure side of machine:



HOW TOTAL COSTS DROP WITH ELECTRIFIED PIPELINES



With electric power, maintenance and labor costs are low and total operating costs drop sharply at reduced capacities, as this chart shows. Actual capacity factor of the nation's pipelines has always averaged less than 100 per cent annually, has even gone as low as 37.3 per cent.

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c = machine movement,
d = tracing pen radial movement $= c^2$.

Combined sides:

x = counter movement,

$x = ack = (bd)^{1/2}k$,

Total time = 100 = T,

t = time chart is on meter gauge,

$x(t/T)$ = volume.

Problem:

a = 70,

c = 50,

Maximum chart capacity = 4800 M cu ft,

k = 0.48,

$ack = 70 \times 50 \times 0.48 = 1680$,

$b = a^2 = 4900$,

$d = c^2 - 2500$,

$(bd)^{1/2} = (4900 \times 2500)^{1/2} = 3500$,

$(bd)^{1/2}k = 3500 \times .0.48 = 1680$,

t = 75,

$x(t/T) = 1680 \times 75/100 = 1260$ = volume.

Double line integrator without means of introducing a coefficient:

The explanation would be like that above, except that k would equal unity and the end result would be a pressure extension instead of a volume.

Single line integrator—Martin-Warner Integrator I:

a = per cent radial travel of counter wheel,

b = per cent radial travel of tracing stylus $= a^2$,

A = 100 per cent radial travel of counter wheel,

B = 100 per cent radial travel of tracing stylus,

t = time chart was on meter,

T = total time in 100 per cent of chart,

H = 10 = (the total number of revolutions of counter wheel at 100 per cent capacity),

h = SR 10 chart average differential pressure reading,

$t/T\ (aH/A) = l_i = t/T\ (bH^2/B)^{1/2}$.

Problem:

a = 70 per cent,

b = 49 per cent,

t = 75 per cent.

$75/100\ (70 \times 10/100) = 0.75 \times 7 = 5.250 = 75/100\ (49 \times 100/100)^{1/2}$,

Average differential reading on SR 10 chart or average square root differential reading = 5.250.

The reading of the counter wheel of the Martin-Warner Integrator I upon completion of a run of the differential pressure line on a Wescott chart, or chart with like characteristics = h.

Operation:

Move tracing stylus, or pen, to point of beginning of differential pressure line, zero counter wheel, follow this line to the point of ending, and take reading from the counter wheel. This reading is, in *all cases*, the average square root differential for volume calculating purposes.

The static pressure calculation, when absolute pressure is involved, is the same as for the differential pressure except that a time factor will have to be applied to the counter wheel reading when the time on the meter gauge is less or more than a full period. This time factor is arrived at as follows:

$$\frac{\text{Total hours in chart period,}}{\text{Total hours chart was on meter gauge.}}$$

An example of correction for absolute static pressure is shown above.

The single line Martin-Warner integrator, like the Foxboro Planimeter, is made for a specific type of chart. For example, if a machine is for Wescott charts, or charts with like characteristics, it cannot be used on a Foxboro chart, and vice versa. * * *

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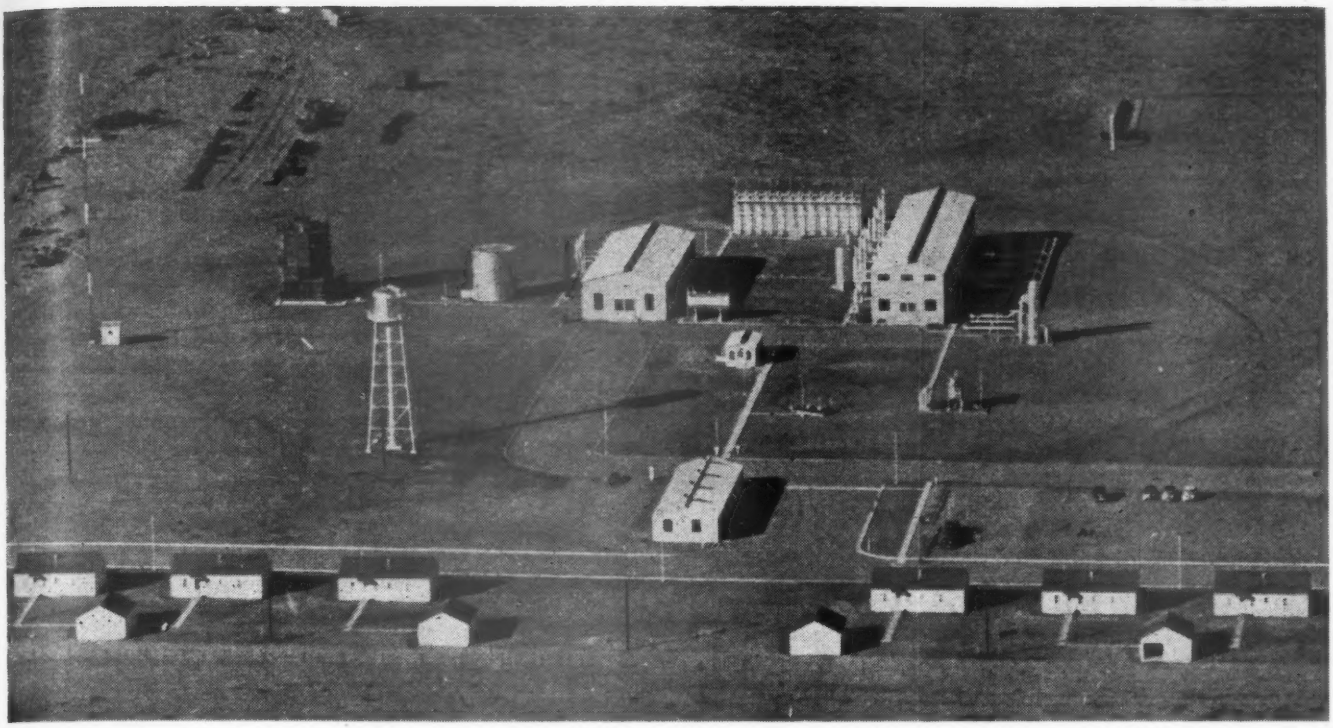


Air view of Kit Carson station.

Kit Carson Station

Latest addition to Colorado Interstate system boosts capacity by 100,000,000 cu ft a day.

HAROLD F. DAWE* and HENRY N. WADE*

PART 1

THE Kit Carson station of Colorado Interstate Gas Company is the latest addition to the already extensive system. The station is situated 13 miles north of Eads, Colorado, on the main 20-in. line transporting gas from the Hugoton field of Kansas to Denver, Colorado, and communities in northern Colorado and Wyoming.

The 1949 construction of the Kit Carson station added the second compressor station to the line constructed in 1947, the initial station being at Lakin, Kansas. The original capacity of the line was 100,000,000 std cu ft per day and the new station, plus added compressors at the Lakin station, increased the capacity to approximately 180,000,000 std cu ft per day. Additions likewise were made at the Lakin dehydration plant to handle the increased capacity and still provide a 25 F maximum dew point at pipe line pressure for the gas entering the line.

*The Stearns-Roger Manufacturing Company.

Compressors

Seven 1200-hp vertical angle type compressors are installed. These engines are each equipped with four 7 by 17-in. stroke compressor cylinders and are arranged with variable clearance pockets to compress gas with suction pressure varying from 400 to 550 psig to a discharge pressure of 800 to 900 psig.

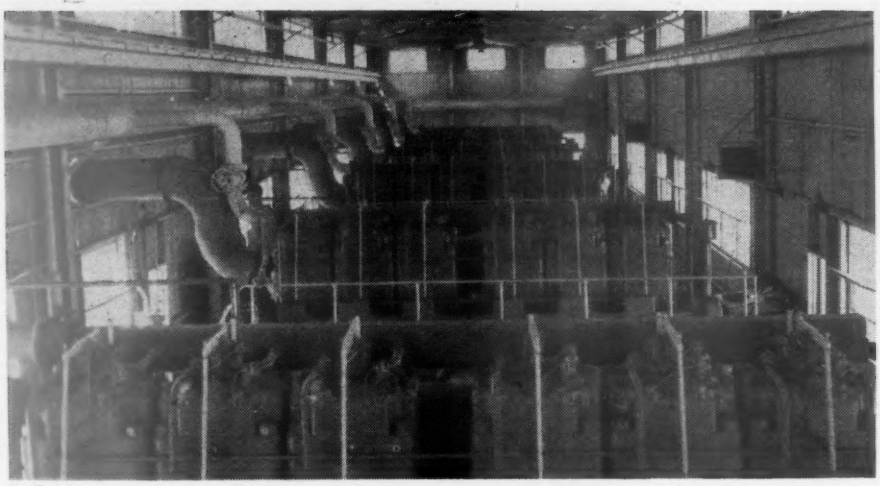
The machines are placed at 90 deg to the axis of the compressor building,

EXCLUSIVE

which is 193 ft long by 34 ft wide, of steel frame covered with corrugated asbestos-cement board.

A soil investigation was made before any foundations were designed and it was determined from the borings that the sub-surface had excellent load bearing characteristics. No difficulty was encountered at any time and no special measures were necessary to stabilize foundations. The compressor station site is naturally well drained at all times, due to the gentle slope to the east.

The compressors are installed on an 18-in. reinforced concrete mat, which serves to support the building walls and provides a floor for the basement. The basement is deep enough to provide 7 ft clearance under all overhead pipes and is large enough to com-



View inside compressor building.

pletely contain all water, fuel gas, and air lines, the oil reclaimers, and dirty oil tanks. An operations entrance to the basement is provided from the main floor midway of the building, and two exits from the basement to the outside are provided. The north end of the compressor building is made of cinder blocks to allow for future expansion.

Each engine has one heavy duty uninsulated exhaust silencer and two oil-bath type air cleaners. The air cleaners and exhaust silencers are mounted on the air intake line in an unique arrangement that provides an explosion head in the exhaust line at the muffler base. Expansion bellows are placed in the exhaust lines to reduce thrust on the engine exhaust manifolds. Each exhaust line is jacketed over an insulating blanket of rockwool. The exhaust line jackets are insulated principally to reduce the drumming noise in the engine exhausts, and secondarily to reduce the heat radiated into the building.

The main gas flow is carried in a 20-in. suction header pipe along one side of the compressor building, and each engine is served by a 10-in. suction line with a large volume bottle mounted above the cylinders. The gas passes through four leads to the individual cylinders.

The discharge volume bottle has a patented pulsation absorber designed into it. A 12-in. discharge line carries the compressed gas through a horizontal expansion bend into the 20-in. discharge header. The suction and discharge of each machine are connected through a bypass valve, which may be used to equalize the suction and discharge pressures. A vent valve is also provided to unload gas from the engine. Safety relief valves are provided on each engine discharge. Vents and reliefs are manifolded onto a vent line, and the line is carried to a stack well away from the compressor building. An elevated walkway is placed on one side of the building to clear all lines and provide a convenient and safe way of getting to the suction and discharge block valves at each engine.

Gas Cooling

The gas piping is carried above ground to a point just beyond the main gas inlet scrubbers, where it goes underground and connects into the main pipe line.

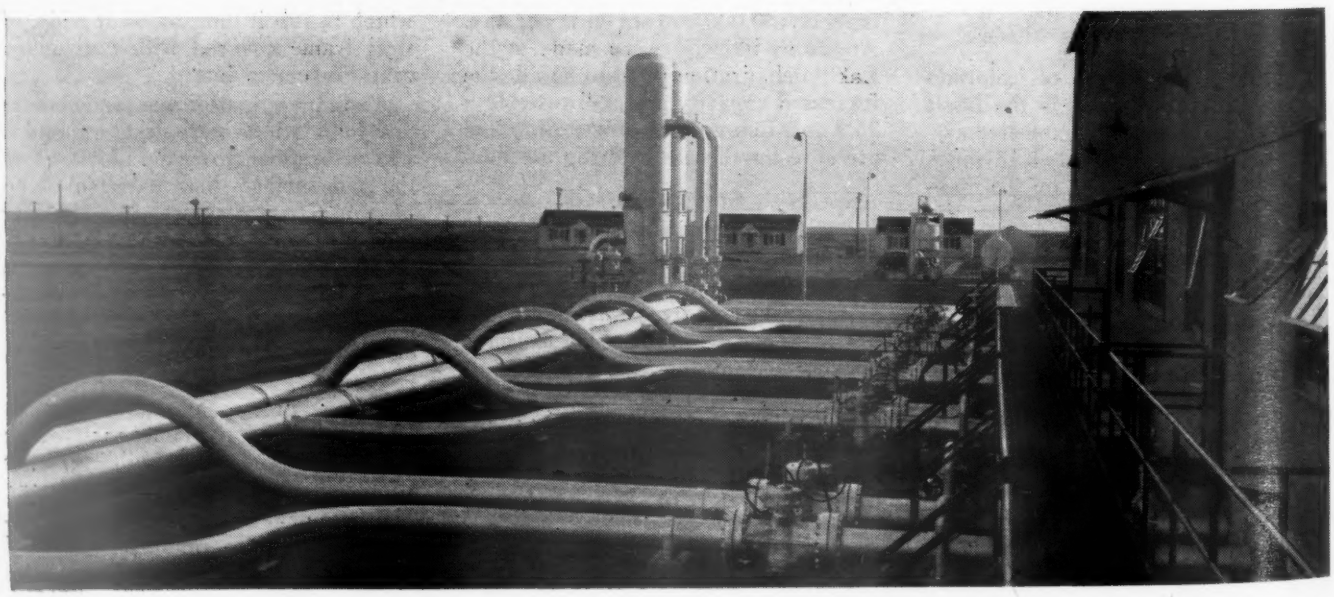
No gas cooling is provided, but arrangements have been made to install it should cooling be considered desirable in the future. As the station operates most of the time below compression ratios that will cause gas temperatures high enough to harm the pipe line coating, and as the decrease in line capacity due to gas temperature is negligible, this design affords a considerable cost saving. Also, cooling water at this location is expensive, hence only absolutely essential duties for water were considered.

Cooling Tower

A small cooling tower of the induced draft type with a 3-bay coil shed and single cell tower was installed to cool the lubricating oil and compressor cylinder cooling water. The cooling tower fan is driven by a 15-hp totally enclosed fan-cooled electric motor.

Cooling water makeup is automatically maintained by a level control, and a recording meter makes possible control of the tower blowdown. A chemical system of cooling water treatment to control algae and scale has

Compressor suction and discharge piping.



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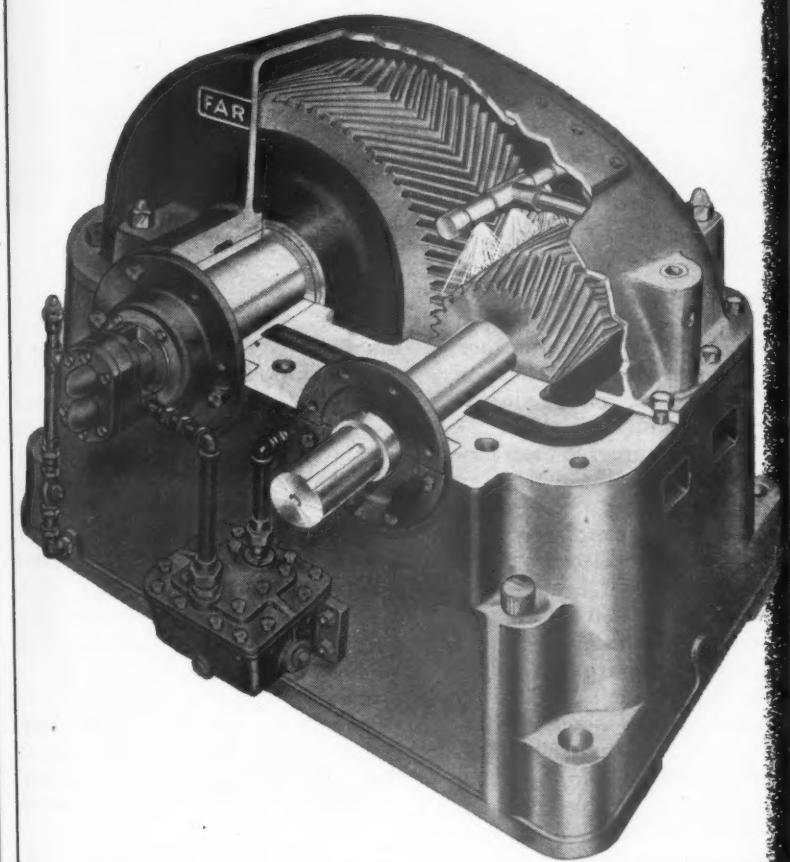

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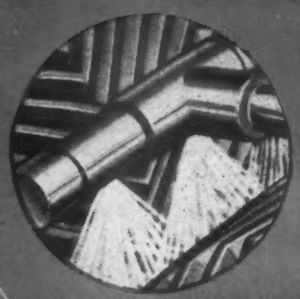

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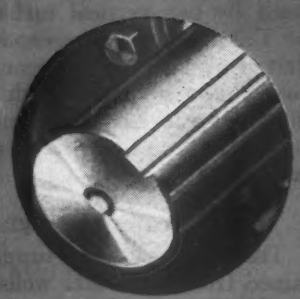

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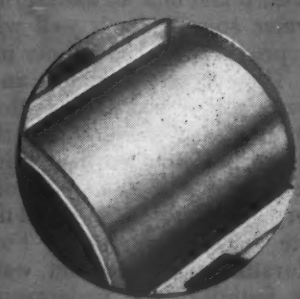

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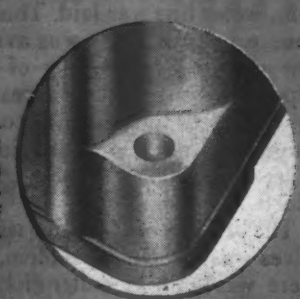
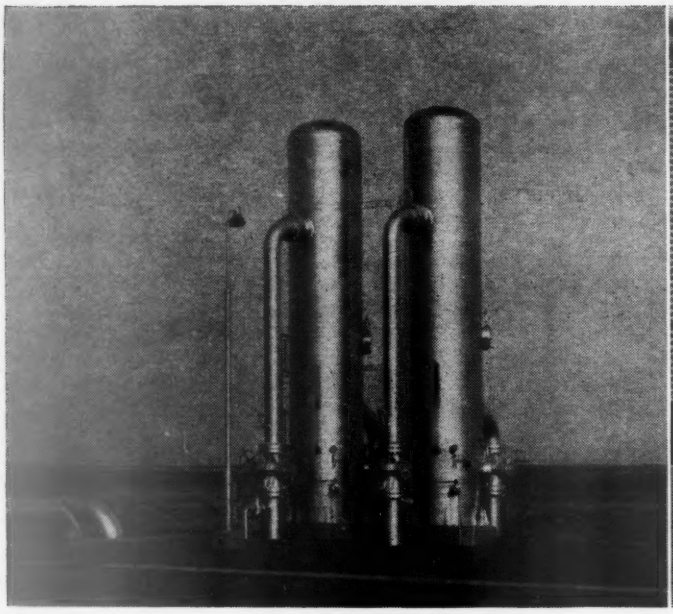
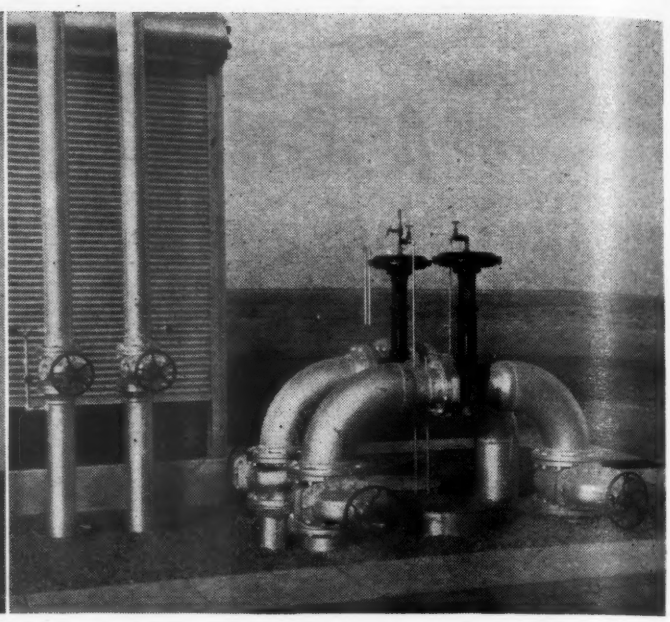




Gas scrubbers.



Jacket water temperature control valves.

been provided, under supervision of a commercial water treating concern.

Cooling tower spray water is circulated by two vertical turbine pumps of 1200 gal per min capacity each, driven by 25-hp totally enclosed fan-cooled electric motors, with a standby unit. Double sump screens are installed between tower basin and pump sump.

Water Supply

The cooling water supply is obtained from two water wells on Rush Creek, 3½ miles from the compressor station. Each well is approximately 25 ft deep and taps an underground river water supply. Each well will supply approximately 150 gal per min.

The difficulty of finding an adequate water supply was great at this station. Originally it was assumed that water would be found on the station site in deep wells. A large number of exploratory borings in and around the station site disclosed no water. Further exploration indicated that water could be found in the underground river source at some distance from the plant. Accordingly, this was developed and a 6-in. water line was laid. This size was chosen because there was available at low cost a large supply of invasion pipe of this size. This line was installed solid-welded, and heavily coated and wrapped. Cathodic protection, using a ground bed and rectifier, has been added.

The drilling of the water wells themselves was a serious problem, because there was nothing but quicksand below the topsoil to build upon. To support the wellhouse and pumps four 15-in. well casings were sunk to shale, approximately 20 ft below surface, and filled with concrete. With these as support foundations, the wellhouse floors were set about 8 ft above the ground in order to provide clearance from flash floods, for the wellhouses are in the main river bed.

Two wells were completed, one pumped by a 7½-hp electric motor and one through a gear head with a similar electric motor and a 10-hp gas engine for emergencies. An electric transmission line runs from the plant to the wells. The voltage is stepped up to 2300 from the 480 plant voltage, and retransformed at the wells. A 4-wire control system is used, operated by level controls installed on the main storage tanks at the plant.

Due to the fact that severe winter blizzards could isolate the station from the water wells, it was necessary to provide an adequate water supply at the plant, consequently a 1000-bbl galvanized and bolted tank was installed. This size was chosen as economical in the installation cost, storage can be amplified easily and economically by additional tanks of the same size should experience indicate more capacity is required.

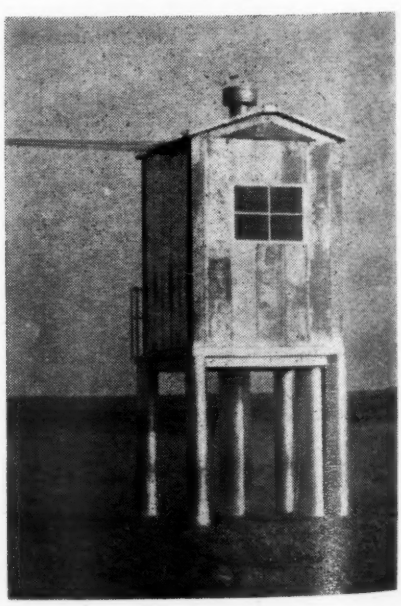
Cooling Water System

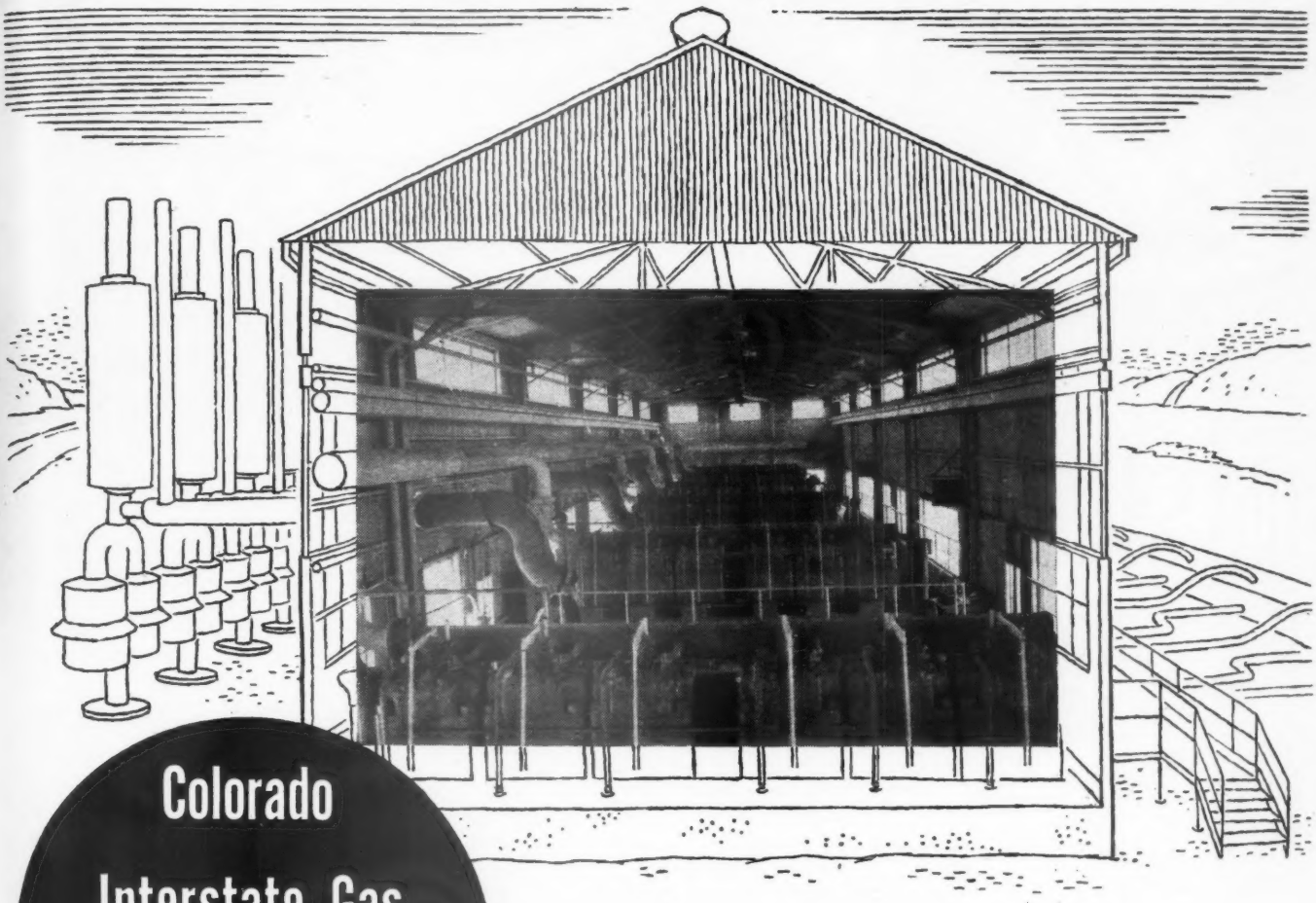
The cooling water system incorporates two separate cooling water circuits. Due to the fact that dry cooling may be used in this locality, and because of the scarcity of water, it was decided to cool the jacket water for the power cylinders in a dry type cooler. This circuit is known as the "hot" jacket water system.

The "hot" jacket water circulates through the compressor and electric generator engine cylinder jackets in parallel into the dry cooler. The desired temperature of the water entering the engine jackets is 140 F. The circulation is designed for about a 10 F rise through the jackets at full load. The dry cooler is designed to cool 6100 gal per min of water from 154.5 F to 144 F with 90 F ambient air at 4300 ft elevation. Advantage is taken of the reduced station load in warm weather to maintain adequate cooling on the machines during the summer.

The dry cooler has three 50-hp two-speed fans forcing air over the finned tubes carrying the water. The fans are controlled by automatic temperature switches set for five steps between

Water well pump house.





Colorado Interstate Gas Company Increases Capacity

Having installed nine BA-6 compressors in 1947 and 1948, Colorado Interstate recently installed ten more BA-6 compressors on their 20" line running from the Hugoton Field in Kansas to Denver, Colorado.

This latest addition of 8400 BHP at the Kit Carson station increases capacity by 50% to 180,000,000 SCFD. Operating pressures vary from suction pressures of 400-550 psig to discharge pressures of 800-900 psig. Further proof of the continued acceptance of the HBA by major pipeline companies.

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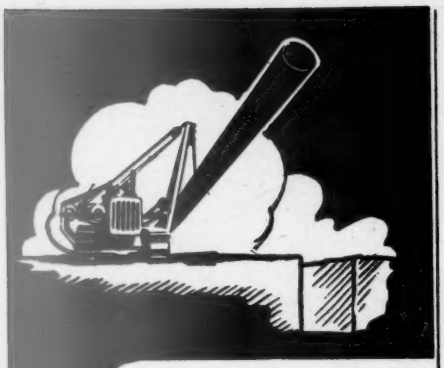

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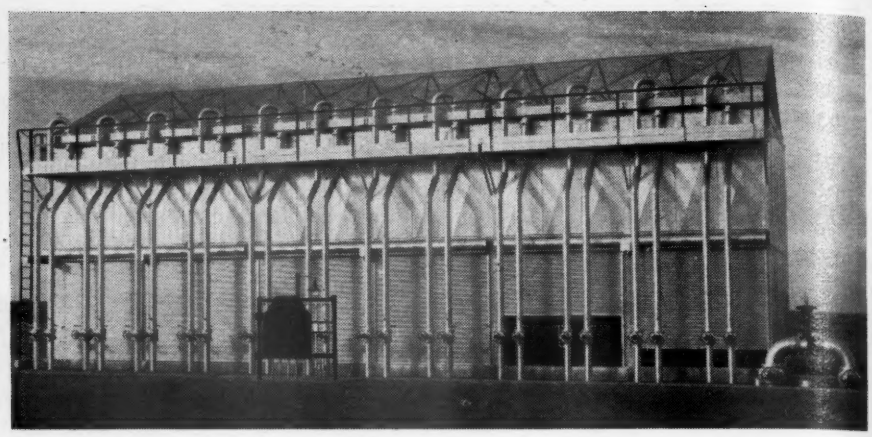

Hot jacket water is cooled in an aerial cooler.

137 F to 150 F. These switches operate the fans at fast, slow, or stop as determined by the temperature.

To facilitate operation with the automatic temperature switches, hydraulic couplings were introduced between the drive motors and the gear box shaft drives. With automatic controls cutting the fans in and out, undesirable voltage surges were introduced. The hydraulic couplings serve to reduce the duration of the voltage dips and allow the motors to attain about 70 per cent of synchronous speed before the fan loads are picked up. This results in much less mechanical strain and generally serves to smooth out operation. As far as is known, this is the first time this arrangement has been used for this purpose.

With dry cooling units of this type, it has been found difficult in cold weather to keep the temperature of the jacket water sufficiently high, even with dead fans, without cutting off some of the coils and decreasing circulation. Under such conditions freezing often damages the dead coils. To overcome this, both ends of the dry cooler structure were solidly closed off and 12 overhead rolling steel doors were installed on the sides. These doors can be completely closed down to cut off practically all natural draft, and thus provide control not otherwise possible. In addition, a large diaphragm bypass valve is installed across the cooler inlet and outlet headers, controlled by a recording temperature controller responsive to the hot jacket water temperature. A differential pressure control valve is installed to provide a uniform pressure drop across the bypass valve, to avoid the difficulty usually experienced with the bypass valve alone.

The hot jacket water is circulated to the compressors and generators through a 24-in. line by means of two horizontal centrifugal pumps in parallel, each driven by 75-hp motors. A spare pump unit is provided. A low water-pressure alarm horn and light is provided in both the generator room and compressor room to warn the operators in case either pump shuts down.

The water from the compressor jackets flows upward away from the engines into an overhead line that discharges into a 10-ft diam by 20-ft high surge tank. Any collected air or gas is released at this point. The pumps take suction from the bottom of the tank. A portion of the "hot" jacket water is circulated under the sidewalk between the auxiliary and compressor building. This serves to heat radiantly the sidewalk and melt off snow and ice during the winter.

The second cooling system is termed the "cold" jacket water system. This system supplies 100 F water to the oil coolers. From the oil cooler the water flows in series through the compressor cylinder jackets where it is heated to about 118 F. The water flows from the jackets into a 4-ft diam by 20 ft surge tank, where any entrained gas or air is removed. The cold jacket water pumps, which take suction from the surge tank, are horizontal centrifugals driven by 30-hp motors. Two pumps are provided, one as a spare. These pumps discharge into six atmospheric sections connected into three parallel stacks of two sections in series, situated in the spray-water cooling tower. A thermostatically controlled bypass valve across the inlet and outlet headers is provided to control the temperature. A differential pressure control valve is installed in this system to provide a uniform pressure drop through the bypass valve.

An 84 kilo-grain zeolite softener in the compressor room basement treats all makeup water to the hot and cold jacket water systems. * * *

This article will be concluded in an early issue.

NOW- UNIQUE METHOD PRODUCING KANEWELD BIG-INCH PIPE ON PRODUCTION LINE BASIS

KANEWELD'S 58 years of fabricating experience is bringing something new to the gas pipe line industry—expanded big-inch pipe, welded through a unique process heretofore unknown to the pipe fabricating craft.

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FIG. 1. Tow and barge containing 22-in. pipe on Cumberland River.

FIG. 2. Cleaning and priming operations in typical rock ditch near Cookville, Tennessee.

Constructing Line to Atomic Energy Plant

ARTHUR B. ALLYNE*

THE first link of East Tennessee Natural Gas Company's pipe line network was completed in December and some 60,000,000 cu ft of gas per day are now being fed to the Atomic Energy Commission's plants at Oak Ridge. Work is scheduled to begin in the next few weeks on the southern portion of the company's system, which will bring natural gas to the Columbia, Tullahoma, Chattanooga, Knoxville, and other East Tennessee market areas by the fall of 1950. Gas for the entire system is supplied by the Tennessee Gas Transmission Company's main line take-offs at Greenbrier and Lobelville, Tennessee.

The Greenbrier-Oak Ridge line runs 165 miles from its take-off at Greenbrier, 30 miles north of Nashville, eastward through rough mountainous country. Solid rock ledges, numerous stream crossings, and unusually heavy rainfall during the 1949 construction season made the completion of this line in a six-month period a major accomplishment.

The 22-in. line to Oak Ridge has a daily capacity of 130,000,000 cu ft of gas without compression and Oak Ridge will initially take gas at the rate of 60,000,000 cu ft a day. The remaining capacity will be available for any future requirements of the Atomic Energy Commission as well as various domestic, commercial, and industrial users throughout East Tennessee.

One of the unusual features of the Greenbrier-Oak Ridge pipe line was the fact that the entire 30,000 tons of steel pipe were barged from the mills to the site by means of the Ohio, Tennessee, and Cumberland rivers. Shipments were scheduled in advance of construction to allow for the two to three weeks required for water transport without at any time interfering with construction progress.

Because of the tremendous quantities of rock encountered in nearly all sections of the 165 mile line it was necessary to keep ditching and shooting operations 15 to 20 miles ahead of pipe laying to avoid possibility of delay from this standpoint. Fig. 2 shows typical rock conditions encountered near the center of the line in the vicinity of Cookville.

Due to the almost continuous occurrence of mountain ridges it was frequently necessary to resort to side hill construction and to use rocky creek beds as the only available right-of-way. In coming off the Cumberland Plateau and across Walden Ridge side hill slopes of as much as 60 deg were encountered as typified by Fig. 3, which illustrates lining and tacking operations under these conditions.

Fig. 4 shows the pipe and ditch in the bed of Flynn's Creek. It was necessary to cross Flynn's Creek 25 times in a single 10-mile stretch in order to get through the mountains east of the Cumberland River and up on to the Cumberland Plateau. In order to protect the pipe from winter floods it was

*Consulting Engineer, Ebasco Services Incorporated.

EXCLUSIVE

FIG. 3. Lining and tacking on sidehill right-of-way near Bitter Creek leaving Cumberland Plateau.

FIG. 4. Water filled ditch in rock bed of Flynn's Creek east of Cumberland River.

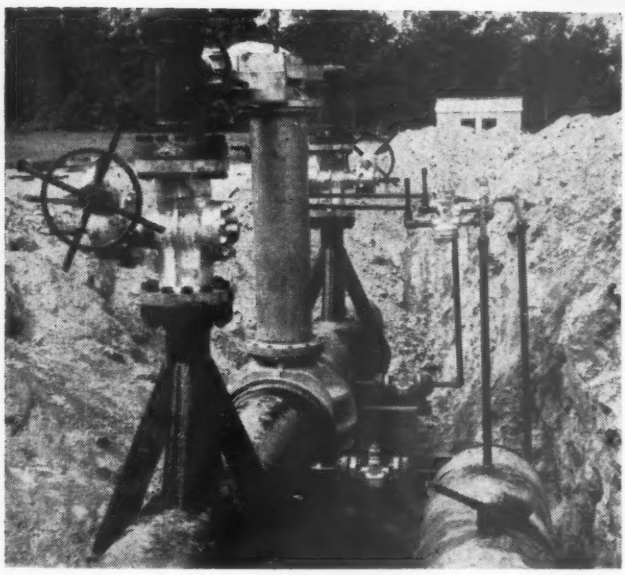

FIG. 5. Automatic cylinder operated main line valve with blowoff and pressure tank at Greenbrier. TGT metering station in background.

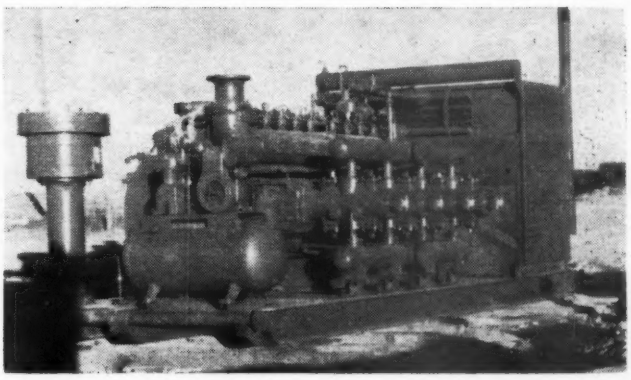

FIG. 6. Portable 350-hp compressor at Greenbrier used for final tests on line at 720 psi.

necessary to use some 300 22-in. cast-iron river weights in Flynn's Creek alone.

Main line valves were spaced at approximately 12-mile intervals adjacent to highways and county roads for easy access and are all 20-in. cylinder operated fully automatic. These valves will shut off automatically the affected section in case of line break. They are believed justified for security reasons as well as confining the loss of gas to the affected section of line. Fig. 5 shows one of the main line valves complete with blowoffs, pressure tank for operation of the piston, and pressure piping at Greenbrier. Also for security reasons the entire line was placed underground. The use of spans was not permitted although it would have greatly facilitated construction in the mountainous country.

In view of the time limitations three big-inch spreads were required to complete the line. Spread No. 1 began work at Greenbrier in the latter part of June, 1949, whereas spreads No. 2 and 3 began work in September and October. The Cumberland River crossing at Ft. Blount was put in by a special river crossing crew drilling the rock bottom from a barge. The crossing consisted of a straight, double 22-in. line buried 4 ft beneath the river bed and equipped with headers and automatic valves.

After completion the line was tested to a pressure of 720 psi by means of line pressure supplemented by a portable 350-hp compressor. Fig. 6 shows this compressor before connections were made to the blowoffs to the main line valve shown in Fig. 5. Upon completing final tests delivery of gas into

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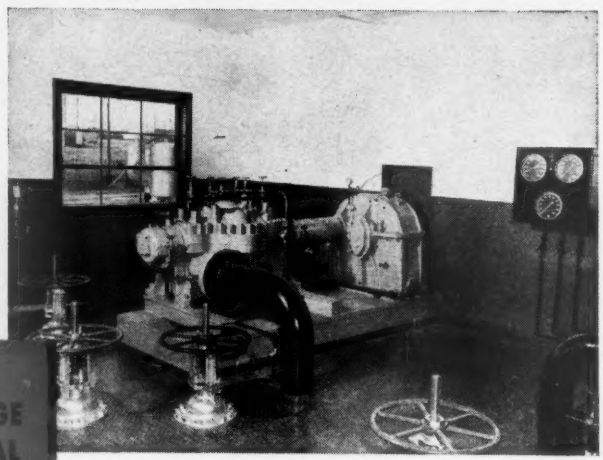

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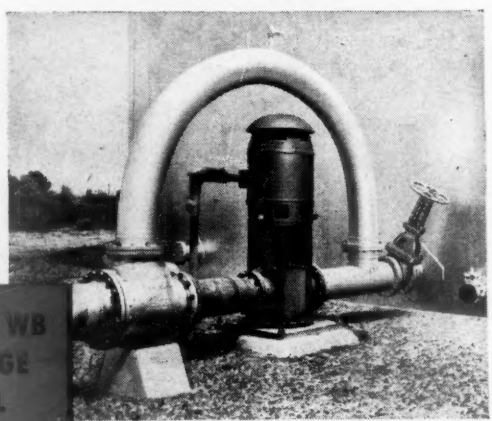

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TYPE WB—Capacities: 1,375 to 17,000 barrels per day; pressures to 2,000 psi.

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Oak Ridge began January 2, 1950.

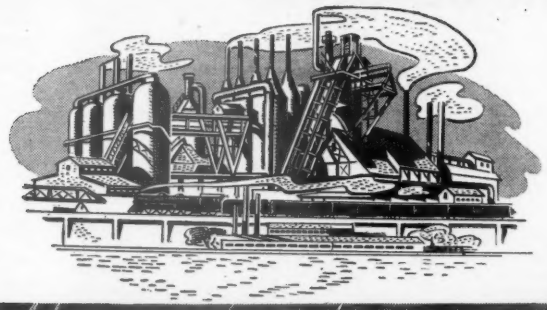
The entire Greenbrier-Oak Ridge line will be protected from soil corrosion by means of cathodic protection. Communications throughout the system will be provided by three radio land stations situated at Greenbrier, Bon Air, and Knoxville, as well as mobile units installed in the company's cars and trucks. The Greenbrier and Oak Ridge land stations will serve as both transmitting and receiving stations whereas the unattended Bon Air land station near the center of the line will act as an automatic booster and relay installation.

Officers of East Tennessee Natural Gas Company are: Wade B. Thompson, president; Frank M. Cantrell, chairman of the board; Herbert S. Walters, executive vice president; Franklin T. Rainey, vice president in charge of operations. The company has construction offices in Knoxville, Tennessee and has announced plans to construct a $150,000 operating headquarters in Knoxville this year.

The line was built by the Oman Construction Company of Nashville, Tennessee associated with the R. H. Fulton Company of Lubbock, Texas. Ebasco Services Incorporated of New York City was responsible for the economic and engineering studies for the project as well as its design and supervision of the actual construction.

J. T. "Jake" Brodie was in charge of field work for Oman Construction Company on the Greenbrier-Oak Ridge pipe line, while B. A. Carrigan and M. L. "Tubby" Boyd were spread superintendents. Ebasco personnel engaged on the Greenbrier-Oak Ridge line were E. K. Wilkins, construction manager; A. B. Allyne, consulting engineer; W. H. Hitchcock, Jr., construction superintendent; G. van B. Slagle, resident engineer, and D. H. Futrell, field purchasing agent. P. J. Delaney was chief inspector; V. J. Worcester, Bennie Williams, and W. O. Kimmey were assistant chief inspectors. Carl Scott, W. O. Coker, C. E. Klanke, Jack Broadway, Jimmie Boyd, and J. B. McMahan served as welding inspectors.

The southern section of East Tennessee's system will be built this year and will consist of approximately 300 miles of 16-in. and 12¾-in. main line and 100 miles of laterals running from the Tennessee Gas Transmission Company's main lines at Lobelville, Tennessee, eastward to Chattanooga, Knoxville, Alcoa, and connecting with the terminus of the Greenbrier-Oak Ridge line at Oak Ridge. East Tennessee and Ebasco Services have recently completed engineering and cost studies for the new work. ★ ★ ★



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WHERE IS THE GO-DEVIL?

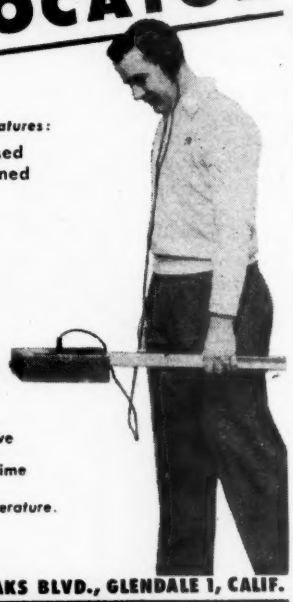
An interesting variation of the pipe cleaning go-devil is the one illustrated here. It is equipped with a series of wire brushes, and has been used to clean corrosive material out of Southern California Gas Company's Goleta pipe line. With the efficiency of the line dropping because of accumulated corrosive material, engineers decided it was time to do a cleaning job, and this instrument was employed. It was sent through the bore in successive sections of from 2 to 10 miles, in the following manner: First move, of course, was to shut down and segregate a section of the line by digging bell holes and removing pieces of pipe at each end. The open ends are temporarily capped to prevent air from entering the line. The go-devil is then inserted and forced through the shut down section by gas pressure in the usual way.

Guy Davies and Leonard Popp, engineers of Southern California Gas Company, are here seen inspecting the radium equipped go-devil.

Usually it takes a pressure of from 2 to 5 psi to move the device through the lines, and when it becomes stuck the pressure may be raised to 10 psi; however, the most interesting feature of this paticular go-devil is that it has a removable cap into which is placed a 500 milligram capsule of radium, and if it should become stuck at any time its location can be quickly determined with a Geiger counter. It might be pointed out, as an additional matter of interest, that in the early stages of the operation the go-devil pushed a 6-ft crowbar through the line without becoming wedged. The bar was one that had been accidentally left inside, probably during the construction period. Despite its effectiveness, however, the go-devil is not used at under-water crossings where the line is smaller. Here the practice is to clean by pulling wire brushes through with a cable. * * *

One Man Gang

GOLDAK model 87 Featherweight PIPE LOCATOR



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NEWS

Whitaker Company Now Texas-Southern Contracting

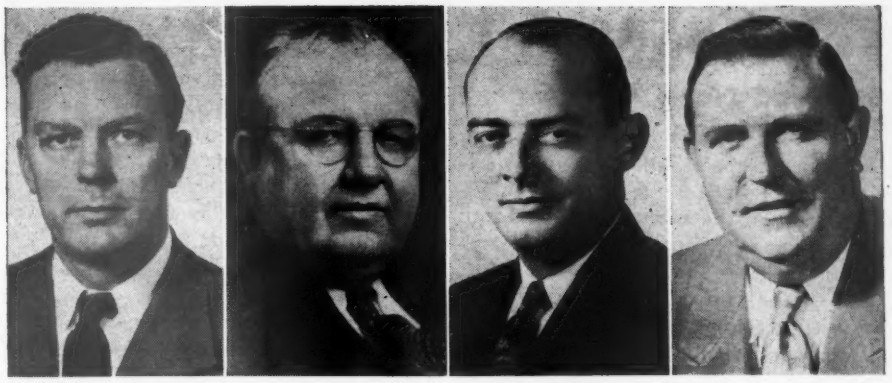
Formal announcement has recently been made that Texas-Southern Contracting Company has acquired the O. C. Whitaker Company and will continue in the pipe line construction business with the same management, equipment, and field organization. O. C. Whitaker Company was a charter member of the Pipe Line Contractors Association and had been active in the field of pipe line construction for many years.

It was first announced that the name of the new company was "Southern Contracting Company." The change to the name "Texas-Southern Contracting Company" was necessary because of a similarity in name to other corporations in various southern states.

President of the new company is Robert Thomas, formerly associated with O. C. Whitaker Company. I. C. Little, Sr., of Dallas, Texas, is vice president, and J. C. Briscoe, also formerly with O. C. Whitaker of Fort Worth, Texas, is vice president and secretary-treasurer. J. C. Minyard is the general superintendent and is widely known for his experience in pipe line construction.

First contract on which the new company started work is for the construction of 92 miles of 30-in. line, designated as Section D, from the Sabine River to Porters, Texas, for Transcontinental Gas Pipe Line Corporation.

Texas-Southern Contracting Company will maintain its headquarters at 804 Dan Waggoner Building, Fort Worth, Texas, formerly the headquarters of O. C. Whitaker Company.



Robert Thomas I. C. Little, Sr. J. C. Briscoe J. C. Minyard

Panhandle Eastern Asks Permit to Export Gas

Panhandle Eastern Pipe Line Company, of Kansas City, Missouri, has asked the Federal Power Commission for authorization to export approximately 27,350,000,000 cut ft of natural gas a year, or an average of about 75,000,000 cu ft a day, to Union Gas Company of Canada, Ltd., which operates in southwestern Ontario.

The application says the gas would be delivered through an existing pipe line crossing under the Detroit River at the International Boundary near Detroit, Michigan. Construction of these facilities was authorized by FPC in April, 1946, at which time the commission also authorized Panhandle to export up to 5,500,000,000 cu ft of gas a year to Union provided the needs of Panhandle's United States customers were met first. Panhandle has exported very little gas to Canada under that authorization due to shortages on its system.

In its new application Panhandle says that part of the gas to be exported will be provided from its own reserves, with the remainder to be purchased from Trunkline Gas Supply Company. Trunkline now has an application pending before the commission for authorization to construct a Louisiana-to-Illinois pipe line. Panhandle said it would transport the gas for Union through additional pipe line capacity proposed in another application on which FPC hearings are now in progress.

Humble to Install Microwave System

On its new system between Houston and Kemper, Texas, now under construction, Humble Pipe Line Company will install a microwave communications relay system 400 miles long. Order for the equipment has been given to Philco Corporation, and Robert F. Herr, president of Philco, stated the system which will parallel Humble's pipe line facilities between the two points mentioned, initially will provide eight voice circuits and a combination of teletype, telegraph, and telemeter circuits.

Operating at frequencies of about 7000 megacycles, wave lengths shorter than a cigarette, the new Philco microwave equipment can readily be expanded to handle 32 voice channels, thus enabling Humble to take care of an additional volume of communications in the future, if desired.

The Humble installation, which will consist of two terminal stations at Houston and Kemper and 18 automatic relay repeaters, or "boosters," will be the longest and most complete microwave radio relay to be installed in Texas.

Mid-Valley to Install Microwave Relay System

The Pony Express, that spanned the early West, has its modern counterpart in the microwave relay system of communications that will be installed by September for the operation of the 1000-mile Mid-Valley pipe line from Longview, Texas, to Lima, Ohio. The Mid-Valley Pipeline Company is jointly owned by The Standard Oil Company (Ohio) and Sun Oil Company.

This will be the world's longest microwave radio relay system. Mid-Valley's system will be five times as long as any existing installation. The present longest system is Bell's New York to Boston television microwave system.

Contract for building Mid-Valley's communications system has been let to the Motorola Corporation of Chicago. It will cost about three-quarters of a million dollars.

Since the curvature of the earth limits the distance between repeater or relay points, towers must be erected 14 to 40 miles apart depending on the use that can be made of hills and high ground. Locations for these relay stations are now being established by surveyors throughout the length of the Mid-Valley pipe line.

It will be possible to have seven or more messages going through one tower at the same time. The dispatching office will be able to send a teletype message to all stations at the same time the Denver, Tennessee, station is sending a voice message to Clarkson, Mississippi, and Hebron, Kentucky, station is talking to the station at Mayersville, Mississippi.

Less than one watt—about the amount needed to light a pocket flashlight bulb—is sufficient power to span the gap between the stations on the microwave system.

The Mid-Valley pipe line will transport crude oil from the producing fields to the refineries of Ohio.

NEWS

Stanolind Name Changed To Service Pipe Line

Service Pipe Line Company has been adopted effective May 1 as the new name of the Stanolind Pipe Line Company, J. L. Burke, president, announces. "This change," Burke said, "has been under consideration for some time and was made in order to eliminate confusion resulting from the existence of several companies bearing the Stanolind name."

"The change emphasizes the separate identity of the pipe line company and 'Service' was selected as most descriptive of the company's function as a common carrier of crude petroleum."

With Service Pipe Line Company now occupying its own new office building in Tulsa, Oklahoma, the change in name will prevent the confusion and inconvenience to the public dealing with the Stanolind Oil and Gas Company and Stanolind Oil Purchasing Company as to the identity of and the services performed by each of these companies.

Parts of Great Lakes Construction Completed

Great Lakes Pipe Line Company began accepting in April an additional million barrels of products from its shippers, consigned to delivery terminals at Kansas City, Kansas, Des Moines and Mason City, Iowa, Mankato and Minneapolis, Minnesota.

This increased capacity was revealed by company officials in connection with a listing of construction progress in the carrier's $55,000,000 expansion program.

Completed are the 12-in. lines from Ponca City and Tulsa to Barnsdall, Oklahoma, and the single 12-in. line from Barnsdall to the Kaw River at Kansas City, Kansas. Work is going forward on the section from the Kaw through the congested industrial area of Kansas City, Kansas, to the company terminal in the Fairfax district and completion is expected soon.

The 12-in. line from Kansas City reached Des Moines April 15. One section north of Des Moines, the 112 miles to Mason City, has been in operation since March 31. Its use increased line capacity to terminals north of Des Moines as gasoline has been pumped through the 12-in. to Mason City and the two existing 6-in. lines have been used solely for pumping to Mankato and Minneapolis.

The 12-in. line also reached Minneapolis April 15. Operation of temporary pumping facilities at Ponca City, Tulsa, Kansas City, and Des Moines will permit transportation of a million barrels a month above existing system capacity.

Shipments to terminals served by the 12-in. line can be increased approximately another 800,000 bbl a month when permanent pumping installations are made.

From Kansas City a 12-in. line is being built northwest to Irvington, a station adjacent to Omaha. When this section is completed the middle of May, shippers will have an option of consigning 250,000 bbl a month of the increased capacity to Omaha instead of moving the entire volume to terminals north of Kansas City.

From Omaha the 12-in. line will be laid northward to terminals at Sioux City, Iowa, and to Sioux Falls, South Dakota. North of Sioux Falls capacity will be gained by construction of a new pumping station at Pipestone, Minnesota, permitting 50-mile pumping on all sections of the existing 8-in. line into Alexandria, Minnesota, and on the 6-in. line from there to Fargo, North Dakota, with Fargo pumping to Grand Forks, North Dakota. Delivery schedules of equipment for the Pipestone station will permit it to be placed in operation July 15.

Completed April 15 was an 8-in. line from Cushing and Drumright, Oklahoma, into Tulsa.

Vance Jenkins Heads NACE; Next Meeting New York

Vance N. Jenkins, research supervisor of the Union Oil Company of California, was elected president of the National Association of Corrosion Engineers at the recent annual meeting in St. Louis, Missouri. N. E. Berry, Servel, Inc., was chosen vice president, and R. A. Brannon, Humble Pipe Line Company, treasurer. Directors representing active members, elected for three-year terms, were H. D. Murray, Cren-Ray Plastic Products Company, and Aaron Wachter, Shell Development Company. Representing corporate members, V. V. Malcom, The Philip Carey Manufacturing Company, was elected for a three-year term. (See pictures page D-51.)

O. C. Mudd, senior corrosion engineer, Shell Pipe Line Corporation, Houston, Texas, received the Speller Award for achievement in the field of engineering.

R. H. Brown, chief of Chemical Metallurgy, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pennsylvania, received the Whitney Award for achievement in the field of corrosion science.

The 1951 annual meeting of the association will be held in New York City.

First Pipe Leaves U. S. Steel's New Texas Mill

The first trainload of large diameter pipe line pipe was shipped recently from the new pipe mill of U. S. Steel's Consolidated Western Steel Corporation at Orange, Texas. Consigned to the Tennessee Gas Transmission Company and destined for a gas transmission line under construction from Texas to the East Coast, the load consisted of 35 cars, each car with 17 lengths of 30-in. pipe 31 ft long. The new mill will produce 50 miles of large diameter pipe a month when full production is reached, serving principally long distance oil and gas pipe lines.

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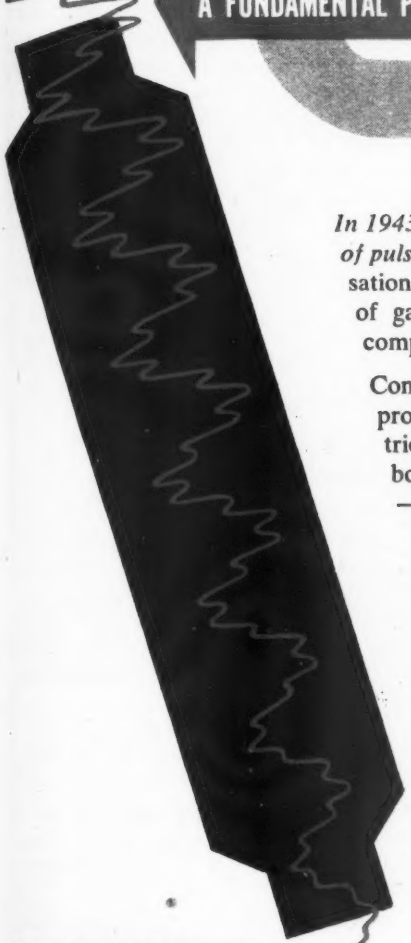

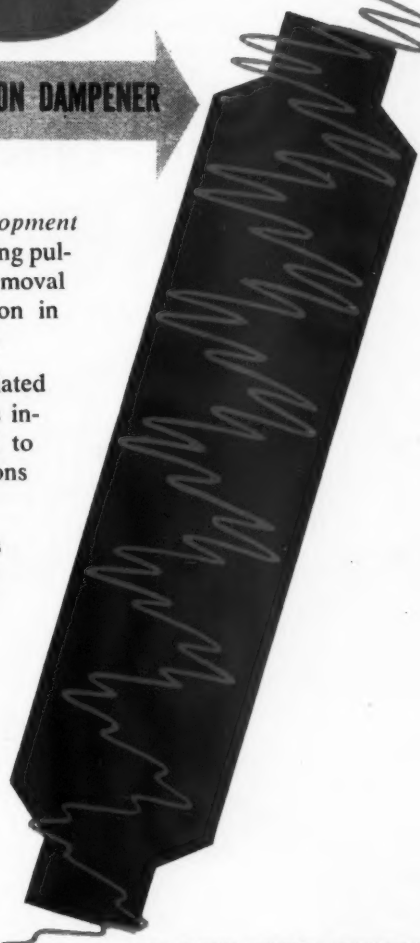

In 1943, The Fluor Corporation pioneered the development of pulsation dampeners. The first U. S. Patent covering pulsation dampeners designed specifically for the removal of gas stream pulsation and subsequent vibration in compressor piping was issued to Fluor in 1946.

Continued research in gas pulsation and its associated problems has established that pulsation, and its intricate secondary vibration, can be attributed to both fundamental and high frequency pulsations *—or to high frequency components alone.*

Whichever of these destructive conditions exists in your plant, Fluor offers a dampener engineered to fit the requirements of the specific problem. Fluor—and only Fluor—offers such a complete range of pulsation dampeners. For this reason you can be assured of an unbiased recommendation on the best type dampener for your *particular* requirements.

THE FLUOR FUNDAMENTAL PULSATION DAMPENER

This type dampener smooths out all pulsations in the gas stream to the extent of at least 85%. All harmonics originally set up in each pulse cycle are automatically reduced or eliminated. This dampener is the guaranteed answer in plants where structural vibration and metering difficulties are encountered—irrespective of pulsation frequency.

MAKE YOUR OWN PRELIMINARY SURVEY

In many cases you can make your own preliminary survey to determine roughly if your pipe vibration is caused by pulsations. Write The Fluor Corporation, Ltd., Los Angeles 22, California, indicating layout of compressor house piping and operating pressures. A procedure will be mailed to you promptly. No obligation.

THE FLUOR HIGHER FREQUENCY PULSATION DAMPENER

This dampener removes objectionable pulsation frequencies encountered above the fundamental. In many instances, it has been found that metering difficulties and vibration of compressor piping and nearby vessels have been caused by the higher frequency components alone. Available in both manifold and in-line types, this dampener is competitive in cost with muffler or snubber type devices.

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Northeastern Gas Hearing Being Held in Boston

The Federal Power Commission hearing on the application of Northeastern Gas Transmission Company for authorization to build a natural gas pipe line system in New England began May 8 in Boston, Massachusetts.

The Northeastern proposal is part of a consolidated proceeding, now in progress, involving several applications, which also include plans for natural gas service in New York State. Northeastern had requested that the place of hearing be changed.

Northeastern is proposing to build a 545-mile pipe line project for the transportation and sale of natural gas at wholesale in the New England states. In addition to Northeastern's application, the consolidated proceedings involve applications of Tennessee Gas Transmission Company and Transcontinental Gas Pipe Line Corporation, which would supply Northeastern's natural gas requirements; New York State Natural Gas Corporation and Niagara Mohawk Power Corporation, which would build pipe line facilities in New York State; and East Tennessee Natural Gas Company. The latter company, however, has asked to have its own application.

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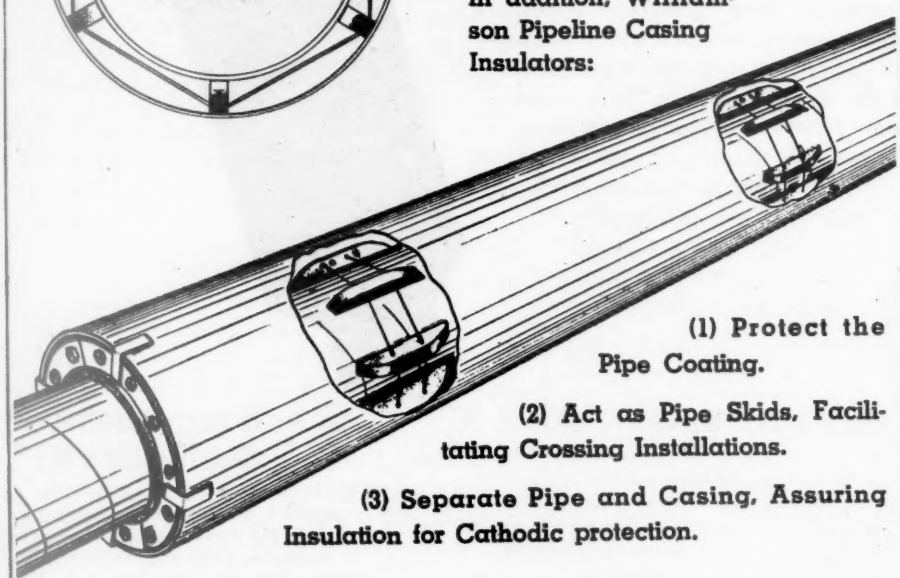
This improved Williamson Pipeline Casing Insulator approximately centers the line pipe in the casing. This removes support of pipe from "WmSEAL" Casing Bushings, and facilitates their installation. In addition, Williamson Pipeline Casing Insulators:



(1) Protect the Pipe Coating.

(2) Act as Pipe Skids, Facilitating Crossing Installations.

(3) Separate Pipe and Casing, Assuring Insulation for Cathodic protection.

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THE PIG WITH THE POKE CLEANS PIPE LINES

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*Patent No. 2,097,398
Other Patents Pending

Somastic Coating for 40 Miles of Gas Line

A major contract has been received by the Somastic Division of the H. C. Price Company, Bartlesville, Oklahoma, from Fish Constructors, Inc., for the coating of more than 40 miles of pipe to be used on the Transcontinental Gas Pipe Line Company's line from Texas to New York City.

This contract, which will be performed at the Somastic Division's Philadelphia plant, includes the coating of more than 100,000 ft of 30-in. pipe. Special equipment was prepared at Bartlesville and shipped to Philadelphia in order to facilitate handling this vast amount of large diameter pipe.

The balance of the 240,000 ft to be coated is broken down as follows: 8800 ft of 20-in.; 8300 ft of 14-in.; 17,500 ft of 12-in.; 9700 ft of 10-in.; 66,600 ft of 8-in.; 15,800 ft of 6-in.; and 1100 ft of 4-in.

Most of this Somastic-coated pipe will be laid in the industrial area of eastern Pennsylvania and New Jersey, where heavy electrolytic action is great.

Construction Begins On California Gas Line

The Southern California Gas Company and Southern Counties Gas Company have begun the construction of an 82-mile, $5,000,000 natural gas transmission line, designed to increase daily gas deliveries from Texas to Southern California by 100,000,000 cu ft.

The contract for construction of the Texas line loop was let to the Midwestern Constructors, Incorporated, of Tulsa, Oklahoma, the Johnson Western Gunite Company of San Pedro, and the L. E. Dixon Company of San Gabriel.

The 82 miles of 30-in., coated, high pressure steel pipe will start from a point on the present Texas-California pipe line at the Whitewater River, northwest of Palm Springs and east of Banning, and will connect to the existing system at a point just west of Puente. The new facility will there be tied into a 30-in. line laid last year in anticipation of this construction. A gas control station will be built at the point of connection.

Route of the line from the starting point is by way of Banning, Beaumont, March Field, south of Riverside, crossing the Santa Ana River just east of Pedley, then across the Chino Valley, south of Chino City, and across the Puente hills to the connection point. The Santa Ana River crossing will require the construction of a 735-ft span suspension bridge.

COROMAT

Field tested, this new underground pipe wrap made by the Owens-Corning Fiberglas Corp., has shown up to 300% greater tensile strength in application than other wraps. This means the practical utilization of the longer 1200 foot rolls at higher wrapping speeds without time consuming delays due to breakage. COROMAT is available in widths from 2 to 36 inches and in 75 to 1200 foot lengths. Price $1.18 per square in carload lots of 8000 squares or more . . . $1.50 per square LCL quantities . . . all prices FOB destination.

GLASFAB

Manufactured by the Lexington Supply Company, GLASFAB, the new hydrocarbon thermoplastic impregnate Fiberglas cloth is impervious to moisture and heat and has a high tensile strength of 92 lbs. per inch. Soft, pliable and non-irritating to the hands, GLASFAB is widely used for handwrapping "hot spots," field joints, field repairs and for machine wrapping river crossings and "hot lines." GLASFAB is supplied in continuous rolls of 75, 400, 800 and 1000 ft. lengths.

KAPCO ROCK SHIELD

KAPCO Rock Shield, a newly developed protective shield for pipe and pipe coating was recently subjected to vigorous tests in the rocky terrain of West Virginia. Dense limestone rocks of varying sizes were dropped from a height of five feet directly on the shield. The electronic detector showed no holidays in the coating following these tests. This new protective shield eliminates the need for padding the ditch under rocky conditions and has also been used with a high degree of success at river and road crossings, padding under river weights, pipe anchors and elsewhere where the coating is subject to damage in handling. ROCK SHIELD is available for early delivery in a Midwestern package which includes strapping, ratchet strapping tool and aluminum seals.

*Manufactured exclusively by Keystone Asphalt Products.

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PIPE LINE PERSONALS

Ray L. Smith, El Dorado, Kansas, president of the Pipe Line Contractors Association, has announced the appointment of the following committees for 1950:

Membership Committee: **R. D. Sheehan,** chairman, **O. R. Smith, R. B. Somerville, Harold Knupp,** and **R. H. Fulton.**

Labor Committee: **T. A. Hester,** chairman, **Wilbur Holleman, A. L. Forbes, Jr., M. S. Williams, James P. Neill,** and **E. J. Mahoney, Jr.**

Committee on Standardization of Specifications: **H. C. Price,** chairman, **J. W. Sharman, A. L. Forbes, Jr., F. E. Stanley,** and **J. C. Britton.**

Committee on Accounting Practices and Procedures: **Paul Dakin,** chairman, **E. L. Gallery, W. W. Teer, Aubrey K. Barlow,** and **T. F. Hansen.**

Committee on Publicity and Planning: **Robert Thomas,** chairman, **Earl Allen, J. R. Horrigan, Van Rosendahl,** and **C. A. Stanfield.**

Program Committee: **R. H. Siegfried,** chairman, **C. Hobson Dunn, L. H. Favrot, L. E. Farley,** and **I. C. Little.**

C. S. Mitchell of Bartlesville, Oklahoma, manager of crude oil supply and transportation for Cities Service Oil Company, has been elected to the board of directors of Cities Service Pipe Line Company, according to an announcement by A. W. Ambrose, president of both companies. A long-time Cities Service Oil Company employe, Mitchell joined the company as junior engineer in 1930, after graduating from North Carolina State's school of engineering. His sphere of service covers both natural gas and oil production, transportation, marketing, and purchasing. After serving in the gas production and transmission fields, he was transferred to Bartlesville in 1939 as a member of the company's purchasing department.

Mitchell served as assistant purchasing agent and, during the war years, handled business relations between the company and various governmental agencies. In April, 1947, he was placed in charge of the real estate department of the company's marketing division at Chicago. One year later, he was transferred back to Bartlesville to manage the crude oil purchasing and sales division. He recently was elected to the directorate of Texas-Empire Pipe Line Company, Kaw Pipe Line Company, and Texas-New Mexico Pipe Line Company.

Clyde Caywood has been named superintendent of the Mullinville compressor station of Northern Natural Gas Company, succeeding **J. H. "Blondy" Goughnour,** who died recently. Caywood has been at the Mullinville station as assistant superintendent since March, 1949, having been transferred there from Oakland, Iowa.

R. J. Evans, district chief gauger at Hobbs, New Mexico, for Shell Pipe Line Corporation, has been transferred to Odessa, Texas, as assistant area gauging inspector. Other personnel changes announced by Shell include: **J. D. Cochran,** field gauger, from Wheeler to Wink. **P. D. Funderburk,** assistant station chief engineer, Hendrick, to station chief engineer at Monahans. **L. L. Gentry,** district gauger, from Monument to Hobbs. **J. T. Hall,** field gauger, Goldsmith to Wheeler. **M. D. Pool,** station chief engineer, Hobbs, to district gauger at Monument. **W. T. Porter,** field gauger, Wink, to district gauger, Goldsmith. **J. W. Powell,** station engineer, Wheeler, to assistant station chief engineer, Hendrick. **E. H. Richardson,** mechanical maintenance supervisor, to instrument maintenance supervisor, Colorado City. **J. G. Robison,** assistant gauging inspector, Colorado City, to gauging inspector, Cushing. **J. A. Scheineman, Jr.,** engineer, Houston to Cushing. **F. L. Underwood,** area training representative to area personnel representative, Houston. **W. W. Williams,** utility man, McCamey, to station chief engineer, Hobbs.

Joe Cahill, who recently resigned as chief engineer of the Continental Pipe Line Company, is now regional manager of Middle West Coating and Supply Company of Tulsa, Oklahoma. His headquarters are in Houston, Texas.

Elmer Kunkle, district gauger for the Eola, Cheneyville, Pipe Prairie, and Big Island fields, has been transferred to the East Mississippi (Brookhaven) district by the Interstate Oil Pipe Line Company.

A. W. Breeland, safety supervisor for Lone Star Gas Company, Dallas, was elected president of the Texas Safety Association at a recent meeting held in Dallas. **E. F. Schmidt,** Lone Star vice president, was elected vice president for membership.

H. E. Burtner, salesman for M. J. Crose Manufacturing Company, Tulsa, is a new member of The Pipe Liners Club of Tulsa. Also recently admitted to membership are **D. C. Kinely,** engineer with Interstate Oil Pipe Line Company, and **Stanley W. Watson,** administrative assistant to the assistant general manager, Stanolind Pipe Line Company.

D. M. Farrell has been named assistant manager of personnel and industrial relations, and **G. H. Miller** assistant superintendent of oil movements by Shell Pipe Line Corporation, Houston, Texas. Farrell formerly was assistant personnel manager in charge of safety and training. In his new job he will assist **Lee Geiler,** manager of the personnel and industrial relations department. Miller will assist **R. C. Nicholson,** superintendent of oil movements.

W. C. "Abe" Martin has been made station superintendent at Campbellsville, Kentucky, by Tennessee Gas Transmission Company. He succeeds **Gene Cochran,** who has been transferred to Load, Kentucky, as construction supervisor of Station 200. **Walter Gwinn,** formerly chief plant repairman at Campbellsville, has been made assistant station superintendent, and **Lonzo Parnell** is the new chief plant repairman.

H. L. Mann, vice president in charge of gas supply for Texas Gas Transmission Corporation will make his permanent headquarters in Shreveport, Louisiana, it has been announced.

Texas Gas established its gas supply office in Shreveport last August to deal with gas proration, engineering, estimating of old and new reserves, deliverability studies, and contracting of new supplies. The company recently placed its new Texas-to-Ohio pipe line in operation.

Mann was engaged in the operation of gas utilities from 1929-1932 in the states of West Virginia, Ohio, and Oklahoma. From 1932 until 1943 he was active in the operations of oil and gas utilities in Texas. He entered the gas business in 1924 in New York City with the Servel Corporation in charge of sales for the original Electrolux gas refrigerator. He left Servel in 1927 to go with the newly formed Union Utilities, Inc., where one of his first assignments was in connection with organization of the Memphis Natural Gas Company, a predecessor of Texas Gas. Mann was president of Memphis Natural, prior to the merger of that company and Kentucky Natural Gas Corporation with and into Texas Gas.

▸ **Charles H. Rich,** former Okmulgee district manager for the Oklahoma Natural Gas Company, has been appointed manager of the Shawnee district, succeeding **Frank Padden,** resigned.

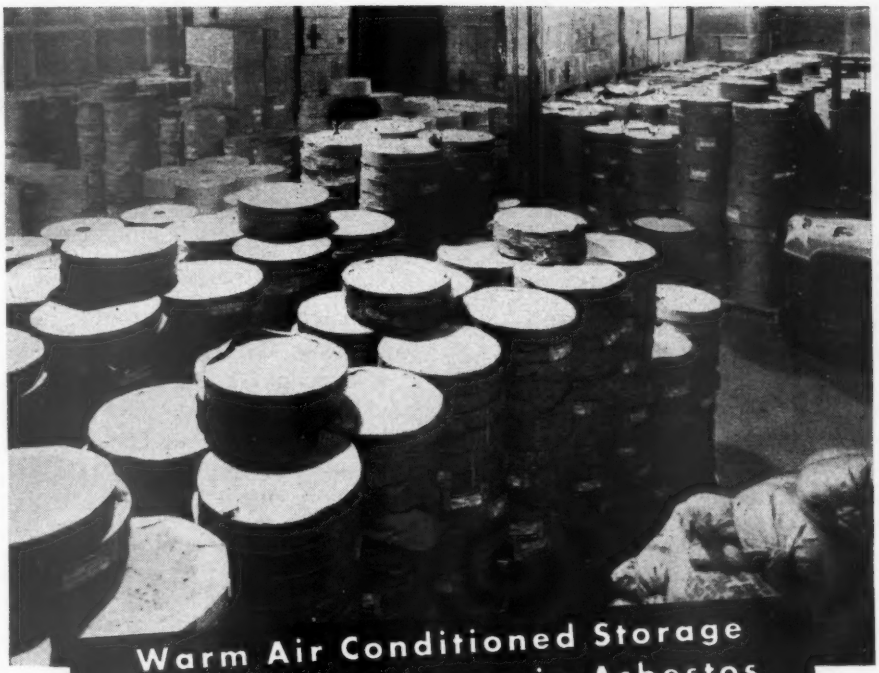
▸ **I. R. Rickey** now supervises all facilities, operations, and personnel for Stanolind Pipe Line Company in the West district of the Missouri Division. **Joe C. Bennett** occupies a like post in the East district. The Missouri Division was recently divided into two districts. The West district extends from the Marais Des Cygnes River (The Kansas and Missouri Division boundaries) to the south head gate at Marceline station and includes the delivery terminal at Sugar Creek. Headquarters are at Carrollton. The East district extends from the south head gate to the Mississippi River and from LaPlata station to and including the delivery terminal at Wood River. Headquarters are at Kirksville.

▸ **Raymond E. Eckel** has been made assistant superintendent of transmission of the Virginia Gas Transmission Corporation. He has been with the company since 1944 when he was employed as an engineer. In 1947 he was made superintendent of main lines. Eckel is a graduate of the University of Colorado.

▸ **Samuel G. Dale,** who has been temporary chief station engineer at Freeman, Missouri, for Stanolind Pipe Line Company, has been promoted to chief engineer. He succeeds **I. R. Rickey** who is now superintendent of the West district of the Missouri Division. Dale joined the company in February, 1925, as a welder-utilityman. His service with the company has been continuous and all of it in Missouri.

▸ **D. S. Skinner,** formerly superintendent of the Rocky Mountain district of Continental Oil Company's pipe line department, with headquarters at Lance Creek, Wyoming, has been transferred to superintendent of the Oklahoma-Kansas district, with headquarters in Ponca City. **R. R. Martin,** who has been employed as district clerk in the Rocky Mountain district at Lance Creek for more than 10 years, has been promoted to superintendent, succeeding Skinner.

Skinner attended the University of Kentucky and joined Continental Oil Company in 1931, assigned to field work in the Oklahoma-Kansas district. He became district foreman in 1943, going to Lance Creek as district superintendent in 1944. Martin attended the University of Oklahoma and went to work for Continental in 1937, as a clerk in Ponca City. He was promoted to district clerk in 1940.



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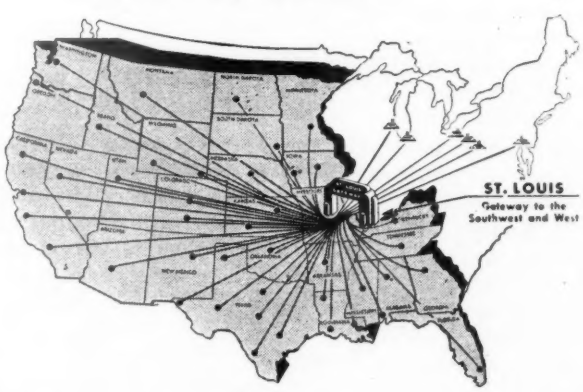

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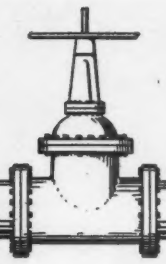
PIPE LINE PROJECTS



Georgia Natural Proposes A 335-Mile Gas Line

Georgia Natural Gas Company, of Albany, Georgia, has applied to the Federal Power Commission for authorization to build a 335-mile pipe line project which would serve natural gas markets in southwestern Georgia and Tallahassee, Florida.

The proposed transmission system, estimated to cost $4,872,593, would connect with Southern Natural Gas Company's line near Phoenix City, Alabama, and extend to Tallahassee, with laterals or branch lines serving the principal cities and towns in Southwest Georgia adjacent to the proposed line.

The company emphasized that its application is not intended to be competitive with that of Atlantic Gulf Gas Company, which now has pending before FPC an application proposing to construct pipe line facilities that would carry natural gas to Georgia, Florida, South Carolina, and Alabama. Georgia Natural said it was filing its application as an alternative proposal in the event that a certificate is not issued to Atlantic Gulf.

Capacity Increase to Phoenix Is Asked

El Paso Natural Gas Company, of El Paso, Texas, is proposing the construction, acquisition, and transfer of natural gas pipe line facilities in order to increase its deliveries of natural gas to Phoenix, Arizona, by approximately 35,000,000 cu ft a day.

The company has applied to the Federal Power Commission for authorization to: (1) Construct approximately 34.2 miles of pipe line and several meter and regulating stations in Pinal and Maricopa Counties, Arizona; (2) build about 10.3 miles of line in Phoenix for transfer to Central Arizona Light and Power Company; (3) abandon several city gate stations in Phoenix and environs; (4) transfer approximately 24.6 miles of existing line in the Phoenix area to the Central Arizona Company; and (5) acquire approximately 11.9 miles of line in Maricopa County from Central Arizona Light and Power. Central Arizona is the distributor of natural gas in Phoenix.

Construction Program of Tennessee Gas Under Way

A $100,000,000 construction program for 1950 was launched in April by the Tennessee Gas Transmission Company, it was announced at the Houston, Texas, headquarters of the company, by Charles S. Coates, vice president in charge of operations and construction.

When the peak of activities is reached by mid-summer more than 6000 construction workers will be on the job along a 1750-mile front stretching from the Gulf of Mexico to Lake Erie, Coates said. The company's natural gas pipe line system will be both enlarged and extended to near Buffalo, New York.

The construction program is designed to increase the system capacity to 1,060,000,000 cu ft a day as previously authorized by the Federal Power Commission. The company is now delivering in excess of 710,000,000 cu ft a day, principally to the states in the Appalachian area.

The increase in capacity to be added this year is to care for expanded markets along the present system and for new markets in Ohio, Pennsylvania, and western New York state. The Tennessee Gas Transmission Company's pipe line system now begins 24 miles from the Rio Grande in South Texas, obtains natural gas from the nation's most abundant natural gas fields along the Gulf Coast of Texas and Louisiana, and presently ends in West Virginia, a distance of 1365 miles. Texas and Louisiana have 70 per cent of the nation's proved recoverable natural gas reserves of 180 trillion cu ft.

The 1950 construction program is divided into two parts. In order to increase capacity so as to permit the additional deliveries, the company will lay 526 miles of 30-in. and 100 miles of 26-in. steel pipe parallel to its existing system at various points in each state crossed by the pipe line. This includes Texas, Louisiana, Arkansas, Mississippi, Tennessee, and Kentucky. Additional gathering lines also will be laid in Texas and Louisiana.

To provide the power to move the additional supplies of gas, the company also will enlarge 10 existing compressor stations, complete a new compressor station begun last year near Agua Dulce, Texas, and construct a new compressor station near Load, Greenup County, Kentucky. Fifty-four new compressor units with a total horsepower of 68,480 will be added during the year to increase the system's total horsepower to more than 300,000.

To increase the reach of the system the company will lay a 385-mile mainline extension of 26-in. pipe line from Greenup County in northeastern Kentucky across eastern Ohio and northwestern Pennsylvania to near Buffalo in western New York state. This project also began in April and will include the laying of a 32-mile 16-in. lateral from the new main line near Bessemer, Pennsylvania, to near Pittsburgh.

W. C. McGee, Jr., general superintendent of operations for Tennessee Gas, said that the extension will be completed in time to provide additional supplies of gas to the new area by this coming winter. With the completion of the extension, the Tennessee Gas system will be 1750 miles long and will reach from the Texas Gulf Coast to near the northeastern shore of Lake Erie.

The work to be done along the existing system as part of the 1950 construction program was outlined by states by Joe J. King, chief engineer, as follows:

TEXAS. Pipe line construction: 32 miles of 26-in. pipe from near Premont, Jim Wells County, to near Agua Dulce, Nueces County, beginning in April, and 72 miles of 30-in. pipe between Agua Dulce and Woodsboro in Refugio County and between Inez in Victoria County and El Campo in Wharton County, beginning in May.

Compressor station construction: Station Zero near Agua Dulce to be completed, including addition of four new 1600-hp engines to give total of eight engines; Station No. 2 near East Bernard, new compressor building and auxiliary buildings, addition of three 1600-hp engines, four new frame cottages for company housing; Station No. 3 near Cleveland, new compressor building and auxiliary

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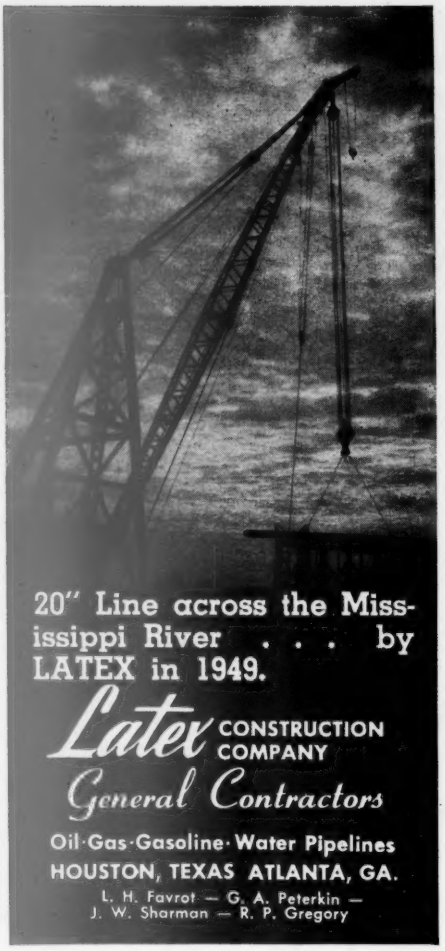
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buildings, addition of six 1600-hp engines; Station No. 4 near Jasper, new compressor building and auxiliary buildings, addition of six new 1600-hp engines. Station construction began in April.

LOUISIANA. Pipe line construction: 90 miles of 30-in. from near Many to near West Monroe, beginning in June; 95 miles of 20-in. lateral from the main line at Natchitoches to near Edna plus additional mileages of smaller lateral gathering lines to connect at Edna. Work began in April.

Compressor station construction: Station No. 5 near Natchitoches, new compressor building, auxiliary buildings, addition of four 1600-hp engines, began in April.

ARKANSAS. Pipe line construction: 32 miles of 30-in. across the southeast corner of the state, starting in June.

MISSISSIPPI. Pipe line construction: 93 miles of 30-in. from near Drew to near Holly Springs, beginning in June.

Mississippi River crossing: Removal of the two existing 18-in. pipe lines on Greenville Highway Bridge connecting Mississippi and Arkansas and construction in their place of four 26-in. pipe lines. Bridge will be redesigned. Present concrete slab roadway will be removed and replaced with steel reinforced concrete deck to reduce present load stress and permit the additional pipe lines. Work to begin in May.

Compressor station construction: Station No. 7 near Greenville, new compressor building, auxiliary buildings, addition of three 1200-hp engines; Station No. 8 near Batesville, new compressor building, auxiliary buildings, addition of seven 1000-hp engines. Station construction began in April.

TENNESSEE. Pipe line construction: 102 miles of 30-in. pipe at intervals along system from near the Tennessee-Kentucky line near Portland to near Selmer, starting in May.

Compressor station construction: Station No. 9 near Middleton, new compressor building, auxiliary buildings, and addition of four 1200-hp engines. Station No. 11 near Portland, new compressor building, auxiliary buildings, addition of six 1000-hp engines. Station construction began in April.

KENTUCKY. Pipe line construction: 137 miles of 30-in. pipe from near Lancaster to near Lebanon and from near Lebanon to near the Kentucky-Tennessee line; 68 miles of 26-in. in Rowan, Lewis, Carter, Boyd and Greenup counties to connect with new compressor station in Greenup County; began in April.

Compressor station construction: Station No. 14 near Catlettsburg, new compressor building, auxiliary buildings, addition of five 1000-hp engines; began in April. Station No. 110 near Morehead, removal of three electric-driven units of 2000-hp each and installation of one advanced-type centrifugal compressor unit of 5500-hp driven by gas turbine. Station No. 200 near Load in Greenup County, preliminary work has started on this new station on 125-acre site to include compressor building with four 1320-hp engines, auxiliary buildings, and nine frame cottages for employe housing.

Gas Line to Southern Georgia Is Proposed

South Georgia Natural Gas Company, of Atlanta, Georgia, is seeking Federal Power Commission authorization to build about 248 miles of pipe line to carry natural gas to distributors in southern Georgia.

The proposed system, estimated to cost approximately $6,600,000, would have a capacity of about 40,000,000 cu ft of natural gas a day. It would include a 144-mile line extending from a connection with Southern Natural Gas Company's proposed extension of its sytem in Talbot County, Georgia, southeasterly to Brooks County, Georgia. A series of eight lateral lines, totaling about 104 miles, would extend from this main line to various Georgia communities.

The application says that it is contemplated that other lateral lines will be constructed from the main trunk line to the distribution systems by the distributors themselves, both private and municipal.

New York State Natural Will Expand Its Facilities

The Federal Power Commission has authorized New York State Natural Gas Corporation, of New York City, to expand its existing natural gas transmission system and underground storage facilities to enable it to meet requirements of its present customers in New York State and Pennsylvania for the years 1951 through 1954.

The construction program, estimated to cost $2,592,582, includes 53.5 miles of 16-in. loop line in Pennsylvania extending from a compressor station in Greene County to another station in Westmoreland County. In addition, the company will replace several sections of pipe at two storage pools, one in Tioga County, and one in Potter County, Pennsylvania.

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with exclusive **SENSICON RECEIVER - NOW AVAILABLE** *in the Dispatcher.*

PERMANENT VALUE of ADVANCED DESIGN

The Sensicon Circuit with the Permakay Wave Filter, Statomic Oscillator, Differential Squelch, Capacitance Discriminator, and Thermally Balanced Crystal Oven, all exclusive Motorola developments, has advanced the art to permit practicable adjacent channel operation. Further, it provides the only uncompromised design capable of accepting full modulation on the desired channel, and adaptable to "split-channel" frequency assignments. With *"Instantaneous Deviation Control"* of the transmitter carrier plus the broad nose, steep skirt characteristic of the Sensicon Receiver, you have an advanced design combination which will give superior performance *now and tomorrow!*

RELIABILITY

Put it in and forget about it! It breezes along with peak performance always. With fixed-tuned, sealed circuits, precision compensated elements, quality components and workmanship—the day of radio tinkering is over! Remember! the Sensicon System is *coasting* while ordinary systems using fewer tubes are taxed to the false-economy limit!

UNIVERSAL PACKAGING

Built for quick and easy installation—with full accessibility, *here is the solution* to any mounting problem in any type of vehicle. Choice of new all-in-one front model, or trunk mount unit—both are drawer-type with quick lift cover. Both units provide for complete metering and antenna alignment through the covered ports on front—yet the complete housing is closed against dust or other foreign particles.

ENDURING ECONOMY

A quality communications unit designed to deliver longer sustained service at the lowest operating cost. New single vibrator power supply provides for minimum tube and vibrator replacement.

FREEDOM FROM OBSOLESCENCE

The growth of land mobile services licensees from 5,000 in 1945 to over 17,000 (over 160,000 transmitters) today indicates that channel-splitting is imminent. With adjustable modulation control, I.D.C., and exclusive exchangeable Permakay filter you have every factor in hand for your future protection.

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MADE BY THE WORLD LEADERS IN 2-WAY MOBILE RADIO BACKED BY 20 YEARS RESEARCH, EXPERIENCE, AND SPECIALIZATION IN MOBILE RADIO

A 150-Mile Line Sought For South Central Alabama

South Central Alabama Natural Gas Company, Inc., of Birmingham, Alabama, is seeking Federal Power Commission authorization to construct approximately 150 miles of pipe line to carry natural gas to south central Alabama. Estimated total cost of the project is $2,500,000.

The company also asked FPC authorization to connect its proposed system with, and to obtain a supply of natural gas from, Southern Natural Gas Company's line in Elmore County, Alabama.

South Central said the proposed system would have a design capacity of 15,000,000 cu ft a day.

Hearings Being Held On Ohio Gas Applications

The Federal Power Commission has separated three proposals involving natural gas service in northeastern Ohio from the current consolidated proceedings on seven other applications which include plans to construct pipe line facilities to carry gas to New York State and New England.

A hearing on the Ohio applications began April 24 in Washington, D. C. The applications were filed by Erie Gas Service Company, Inc., Lake Shore Pipe Line Company, and Grand River Gas Transmission Company.

The FPC action was requested jointly by the three companies, which are competing for the Ohio market, and Tennessee Gas Transmission Company, which is proposing to deliver 17,000,000 cu ft of gas a day to whichever company is certified by FPC to serve the Ohio area.

The three Ohio companies all propose to obtain gas from Tennessee Gas Transmission near Meadville, Pennsylvania.

Commonwealth Permitted to Serve Virginia Markets

The Federal Power Commission has issued an order authorizing Commonwealth Natural Gas Corporation, of Lynchburg, Virginia, to construct a 200-mile pipe line that will serve natural gas markets in Virginia, including Richmond and Norfolk.

In a concurrent order, the FPC denied the portion of the application of Piedmont Natural Gas Corporation, of Spartanburg, South Carolina, which proposed to serve markets in the tidewater area of Virginia, but reopened that proceeding insofar as it relates to Piedmont's plans to supply natural gas to the Piedmont region of the Carolinas.

In its order approving the Commonwealth project, the Commission authorized Virginia Gas Transmission Corporation, of Charleston, West Virginia, to deliver and sell 55,000,000 cu ft of gas per day to Commonwealth. In addition, Tennessee Gas Transmission Company, of Houston, Texas, was authorized to sell 20,000,000,000 cu ft of gas per year to United Fuel Gas Company for resale to Virginia Gas to enable the latter company to supply Commonwealth's requirements.

Commonwealth's line will connect with Virginia Gas Transmission's system in Greene County, Virginia, and extend to Norfolk and Newport News. Virginia Gas Transmission will construct a measuring and regulating station at the point of connection.

Commonwealth and Virginia Gas were directed to begin construction of the newly-authorized facilities by July 1.

In its order relating to the Piedmont application, the Commission said that because of the need for natural gas in the Piedmont area of the Carolinas and the showing already made by the applicant, the proceeding should be reopened for the purpose of allowing the company to amend its application to serve the Piedmont area and to produce further evidence if it so desires. Piedmont was directed to act within 60 days.

Piedmont, which was seeking authorization to build a pipe line from Chambers County, Texas, to the tidewater area of Virginia, proposed to serve communities in North Carolina, South Carolina and Virginia, to supply five of Duke Power Company's electric generating plants with interruptible gas, and to provide firm industrial service to the Solvay Process Plant of the Allied Chemical and Dye Corporation at Hopewell, Virginia, and the Celanese Corporation near Rock Hill, South Carolina.

FPC said that while there is a substantial demand and need for natural gas in the communities proposed to be served in the Piedmont area, the company, because of its present agreement for sale of gas to Duke, is not contractually free to offer natural gas on terms and under conditions that are sufficiently favorable to all classes of consumers to justify the issuance of a certificate.

The commission's order authorizing the Commonwealth, Virginia Gas and Tennessee proposals also permitted withdrawal of applications by two other companies, Virginia Natural Gas Company and Eastern Natural Gas Company, which previously had proposed to serve markets in Virginia.

Pipe Lines to Storage Fields Are Approved

The Federal Power Commission has authorized United Fuel Gas Company, of Charleston, West Virginia, to construct and operate a total of 12 miles of pipe line for the transportation of natural gas to and from two underground storage pools in West Virginia.

The 12 miles of pipe line, which include 3 miles of 10¾-in. line and 9 miles of 20-in. line, will transport natural gas received from the Tennessee Gas Transmission Company pipe line system to the storage pools in West Virginia, one near Nitro and the other near Clendenin.

Great Lakes Will Lay Second 12-in. Line

A second 12-in. pipe line will be constructed between Barnsdall, Oklahoma, and Kansas City, Kansas, and pumping stations of Great Lakes Pipe Line Company will be further enlarged at Barnsdall and Humboldt, Kansas, Harry Moreland, president, announces.

The new line, which will parallel a 12-in. recently completed and three existing 8-in. lines, is another phase of the current $55,000,000 expansion program of the products pipe line company. Construction of the new line will begin as soon as pipe can be delivered with completion expected sometime this fall. Cost of program is estimated at $6,629,890.

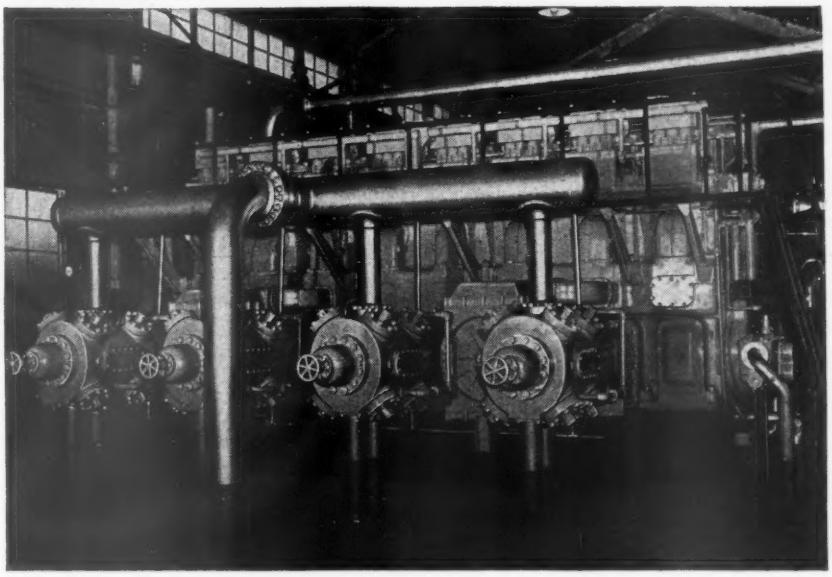
The projected line will equalize capacity of the two 12-in. lines into Barnsdall with two lines of similar capacity out of Kansas City, one north to Minneapolis, Minnesota, and the other northwest to Sioux Falls, South Dakota.

The first 12-in. lines south of Kansas City are finished, the line north is in final stages of completion, and construction of the line to the northwest is started. This latest announcement brings to 1300 miles the total of 12-in. lines projected in the expansion program. A 50-mile 8-in. from Cushing and Drumright to Tulsa, Oklahoma, is also under construction.

Matching line capacity into and out of Kansas City provides the most economical accommodation for transportation needs of Oklahoma and Kansas refiner-shippers of Great Lakes, company officials said. Upon completion of authorized line, station, and terminal construction the company will be able to transport through its system approximately 63,000,000 bbl of products a year by operating 12-in. lines on 100-mile pumping and other lines with stations operating at 50-mile intervals.

PIPELINE OFFICIALS GATHER TO SEE REVOLUTIONARY NEW ANGLE GAS ENGINE COMPRESSOR

Tennessee Gas Transmission Company's New Worthington Uniflo TYPE UTC-16 Draws Visitors From Near And Far



The Tennessee Gas Transmission Company's new Worthington Angle Gas Engine Compressor — uniflo TYPE UTC-16 — installed at Monroe, La. The Company's natural gas pipeline will reach Buffalo, N. Y., and further extension is planned.

So widespread was the interest in Worthington's new Angle Gas Engine Compressor, TYPE UTC-16, that engineers and other executives from transmission companies all over the country came to see the first of these units in actual service — at the Tennessee Gas Transmission Company's Monroe, La., plant.

Advance notices of outstanding performance were fully lived up to, observers being particularly enthusiastic over the new uniflo scavenging. This radical improvement over conventional loop design provides more than double the port area and 50% more exhaust area. Straight-line air flow thoroughly cleanses and cools the entire cylinder, and timed valves retain greater weight of pure air for perfect combustion and stepped-up supercharging.

Features For Top Performance

En bloc frame, with removable cylinder liners . . . double air manifolds . . . completely symmetrical outer piston walls, wrist-pin in separate carrier . . . cone-type cylinder head, with streamlined passages and two large exhaust valves gear driven camshafts for positive drive and perfect timing . . . positive pressure lubrication through cast-in manifolds to all moving parts . . . large access doors on both sides of frame for complete accessibility . . . Worthington Feather* Valves, most efficient ever made, in all cylinders.

Wide Usefulness

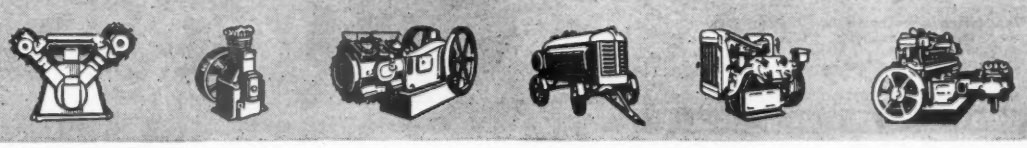
On pipeline duty, in refinery service— in fact, wherever gas must be compressed and suitable gas fuel is available — the uniflo TYPE UTC-16 offers dependability and economy never before possible . . . proof that, as always, *there's more worth in Worthington.* Learn more about this outstanding advancement in angle gas engine compressors Contact your nearest Worthington Branch Office or the *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

WORTHINGTON

*Reg. U. S. Pat. Off.

EK-0-2

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



Applications of Two Companies Consolidated

The Federal Power Commission has consolidated the proceedings involving the applications of Transcontinental Gas Pipe Line Corporation and Carolina Natural Gas Corporation. A hearing on the latter proposal began May 1 in Washington, D. C.

Carolina Natural is proposing to construct a system of lateral pipe lines to supply natural gas to distributors now serving manufactured gas in communities in North and South Carolina, and has asked FPC for an order directing Transcontinental to supply the natural gas for the project.

Carolina Natural would build approximately 372 miles of pipe line, consisting of 18 lines having an aggregate design capacity of 140,000,000 cu ft a day.

The portion of Transcontinental's application relating to the New England service previously was consolidated with several other applications, including Northeastern's, and that proceeding is currently in progress.

Carolina Natural, which has its main office in Charlotte, North Carolina, estimates cost of its project at $7,332,200. Transcontinental's home office is in Houston, Texas.

East Tennessee Application To be Heard Separately

The Federal Power Commission has separated East Tennessee Natural Gas Company's application from the current consolidated proceedings involving six other applications, which include, among other things, plans for natural gas service in New England. No date was set for further hearing on the East Tennessee application.

The action was requested by East Tennessee, which is proposing an extension of its pipe line system from a point near Knoxville to Bristol.

East Tennessee's application was consolidated March 15 with the proceedings involving the six other applications. At that time East Tennessee was attempting to obtain an additional volume of approximately 40,000,000 cu ft of natural gas a day from Tennessee Gas Transmission Company.

East Tennessee subsequently requested that its application be heard separately, stating that Tennessee Gas has agreed to enter into a contract for delivery of up to 40,000,000 cu ft of gas a day. The contract is to be executed when East Tennessee completes construction of presently authorized pipe line facilities in Tennessee. Tennessee Gas then will apply in a separate proceeding for FPC authorization to supply the requested gas to East Tennessee.

The commission also granted the requests of East Tennessee; Watauga Valley Gas Company; Bristol Gas Corporation; City of Elizabethton, Tennessee; Kingsport (Tennessee) Chamber of Commerce, Incorporated; City of Johnson City, Tennessee; City of Bristol, Tennessee, and City of Bristol, Virginia (jointly); the State of Tennessee and the Railroad and Public Utilities Commission of the State of Tennessee to withdraw their intervention in Tennessee Gas Transmission Company's application.

Interprovincial Line In Operation by End of Year

Interprovincial Pipe Line Company's present work schedule calls for one of the fastest pipe line construction jobs in history, the company's first annual report disclosed.

Dr. O. B. Hopkins, president of Interprovincial, said that crude oil is expected to enter the 1180-mile line at Edmonton this fall and reach the Great Lakes by the end of the year. It will be stored at the lakehead until the opening of navigation in the spring of 1951 when lake tankers will deliver it to Ontario refineries.

"While there have been pipe line projects of greater magnitude than the Interprovincial line, none has had such a short working period set for completion," Dr. Hopkins said. "Everything possible is being done to complete the work as scheduled—particularly in view of the importance to the Canadian economy of an additional crude outlet."

Field men, making use of aircraft, snowmobile, and even horse-drawn sleds, have now obtained options on about 90 per cent of the Canadian and 75 per cent of the U. S. right-of-way for the line. Construction will employ between 1000 and 1500 men, working out from as many as 10 different points.

The company's report shows total asset figures (all in Canadian currency) of $19.1 millions at December 31, 1949. Of this amount, $4.9 millions represents investments in property, right-of-way, engineering, etc. Most of the other assets consist of cash and funds held in trust for future expenditures.

The company's financing is reflected in the balance sheet by capital stock of $1,108,000 and by convertible debentures of $16,999,000. First mortgage bonds amounting to $72 millions have been subscribed and will be issued in 1950.

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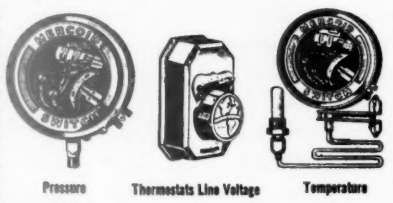
SOLVES INDUSTRY'S AUTOMATIC CONTROL PROBLEMS

THE ONLY 100% MERCURY SWITCH EQUIPPED CONTROLS

The distinguishing feature of Mercoid Controls is the exclusive use of Mercoid hermetically sealed mercury switches. These switches are not subject to dust, dirt or corrosion, thereby assuring better performance and longer control life.



Pressure | Thermostats Line Voltage | Temperature

Explosion Proof | Thermostats Low Voltage | Liquid Level

Float Operated | Oil Burner Safety | Transformer-Relay

If you have a control problem involving the automatic control of pressure, temperature, liquid level, mechanical operations, etc., it will pay you to consult Mercoid's engineering staff—always at your service.

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Specify PELCO Welding Saddles

PELICAN WELL TOOL & SUPPLY CO.

P. O. Drawer 1108
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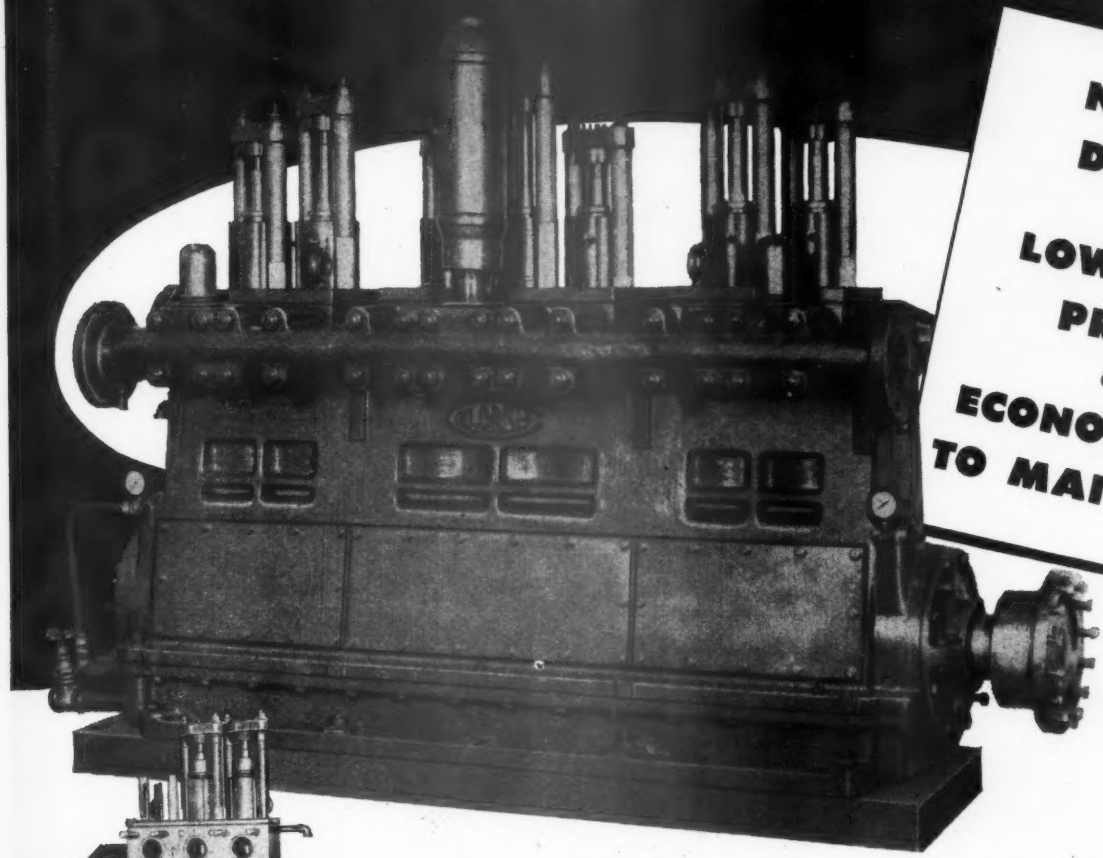
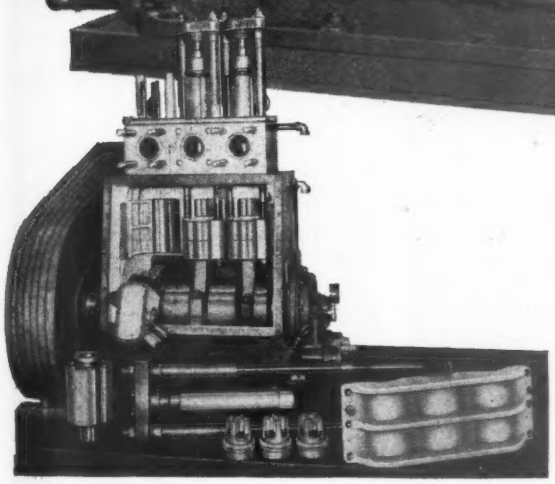
SEE YOUR NEAREST SUPPLY HOUSE

These Aldrich 5" Stroke Direct Flow Pumps are:

NEW IN DESIGN
•
LOWER IN PRICE
•
ECONOMICAL TO MAINTAIN



Aldrich 5" Stroke Direct Flow Septuplex Pump



● A partially dismantled 5" Stroke Direct Flow Triplex Pump. The fluid-end block is bolted to the top of the frame. The suction and discharge manifolds, bolted to the working barrel, serve as clamps to hold the valves in place. To remove valves, it is only necessary to remove the nuts from the holding studs. Manifolds can then be slid on the studs, affording sufficient room to remove and replace valves which are assembled in complete units for ease of handling.

Making quality construction available at a *new low in price,* Aldrich 5" Stroke Direct Flow Pumps are designed for serviceability and economy of maintenance. Built in 3, 5, 7 and 9 cylinder units, the series ranges from 75 to 275 hp and handles almost all liquids encountered in oil field and petroleum service.

NEW IN DESIGN: One outstanding advantage of these pumps is the *sectionalized* fluid-end. Combining several separate units, the fluid-end consists of: a working barrel, valve assemblies, stuffing boxes, and suction and discharge manifolds. Designed to afford close clearance volumes and direct flow, these pumps are ideal for handling light as well as heavy liquids. Removable stuffing boxes and two basic sizes of fluid-ends permit change of plungers, from 1¾" to 3½" diameter, to meet desired pressure and capacity requirements.

ECONOMICAL TO MAINTAIN: As a result of the sectionalized fluid-end, one man can easily remove and replace valve assemblies. And individual fluid-end parts can now be replaced at a *fraction of the cost* of a composite type fluid-end. Other savings include: interchangeability of wearing parts, less costly pump housing, lower foundation expense, low skidding cost, ease of portability, and light weight.

Write—without obligation—for complete information. Request Data Sheet 64-B.

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THE ALDRICH PUMP COMPANY

26 PINE STREET, ALLENTOWN, PENNSYLVANIA

All Aldrich Pumps Have **STAYING POWER**

PICTORIAL

Pictures on this page were taken at meeting of Southern Gas Association in Galveston.

From Ohio came J. W. Polkinghorn, John Kirtley, and A. L. Roberts of Texas Gas Transmission Corporation.

Hiram Moore and Charles Coates of Tennessee Gas Transmission Company, Horace Sanders of Cooper-Bessmer Corporation, and W. T. Thagard of Texas Eastern Transmission Corporation.

New officers of SGA: H. V. Conkey, treasurer, Southern Union Gas Company, Dallas, Texas; J. H. Wimberly, second vice president, Houston Natural Gas Corporation, Houston, Texas; Carl H. Horne, president, Alabama Gas Corporation, Birmingham; E. T. Anderson, secretary, Atlanta Gas Light Company, Atlanta, Georgia; L. L. Dyer ,first vice president, Lone Star Gas Company, Dallas.

Paul Kayser, president, El Paso Natural Gas Company, speaking before SGA.

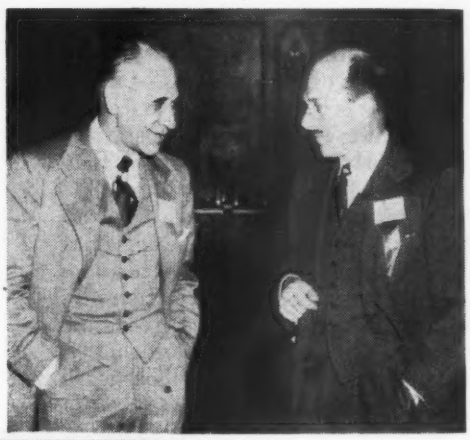
E. R. Cunningham of Texas Eastern Transmission Corporation presided over one of the transmission sessions.

L. L. Baxter, president SGA, addresses the general session. Others on speakers' rostrum are: C. H. Zachry, left, Southern Union Gas Company; Hugh H. Cuthrell, president American Gas Association; Robert R. Suttle, managing director of SGA, and Dr. Arthur A. Smith, chairman, Department of Economics, Southern Methodist University.

Pictures on this page were taken at meetings of National Association of Corrosion Engineers in St. Louis.

Right, seated: V. V. Malcom, The Phillip Carey Manufacturing Company, a new director of NACE; Ivy M. Parker, Plantation Pipe Line Company, chairman, Publications Committee; T. F. P. Kelly, James E. Mavor Company, a new director. Standing: R. A. Brannon, Humble Pipe Line Company, new treasurer; Norton E. Berry, Servel, Inc., vice president elect; Vance N. Jenkins, Union Oil Company of California, new president of NACE; Maynard H. Jackson, Middle West Coating and Supply, past director; H. D. Murray, Cren-Ray Plastic Products Company, new director.

Group of Socony-Vacuum Oil Company men present at NACE meeting: Harry K. Phipps, Chas. M. Brecheisen, H. L. Bedell, L. R. Dickinson, Bruce L. Corey, J. Albert Rupp, D. E. Miltner.



S. S. Smith, Products Pipe Line Department, Shell Oil Company, and A. Wachter, Shell Development Company, a new director of NACE.

G. E. Seidel, Amercoat Corporation, new chairman of exhibits committee, NACE; L. B. Donovan, Consolidated Edison Company, new general chairman; Norman Hackerman, University of Texas, technical program chairman. On the right are L. O. McCormick, Consolidated Gas Electric Light and Power Company, and H. H. Anderson, Shell Pipe Line Corporation.

A. W. Peabody and M. C. Miller of Ebasco Services Incorporated and George McComb of Standard Pipeprotection, Inc.

Tom Holcombe, Holcombe and Stearns, Inc., a retiring director, and W. A. Broome, Arkansas Louisiana Gas Company, member of technical practices committee.

With the PIPE LINE CONTRACTORS

Midwestern Constructors, Inc., 105 North Boulder Street, Tulsa, Oklahoma, has started the right-of-way, and other equipment is being moved in, to lay 83 miles of 30-in. pipe near Riverside for Southern California Gas Company and Southern Counties Gas Company of California. The contract was taken as a joint venture with **Johnson Western Gunite Company** and **L. E. Dixon Company** of Los Angeles. The field office is at Banning, California.

The contractor is laying three sections of the Great Lakes Pipe Line Company's new work. Operations began April 10. Section 23 consists of 47 miles of 12-in. between Atchison, Kansas, and Falls City, Nebraska. Section 24 is 47 miles of 12-in. from Falls City to Nebraska City. Section 25 extends from the latter point to Omaha and consists of 48 miles of 12-in.

Work is scheduled to begin June 1 on 69 miles of 26-in. loop lines from Olpe to Hugoton, Kansas, for Panhandle Eastern Pipe Line Company.

A job has been contracted with Northern Natural Gas Company, scheduled to begin July 1. This consists of laying Section 6, 43.4 miles of 26-in. between Palmyra, Nebraska, and Oakland, Iowa, and Section 7, 65.9 miles of 26-in. northeastward from Oakland.

The company is doing the engineering on 120 miles of 4 through 24-in. gathering lines for Plains Natural Gas Company in Kansas. The field office is at Liberal, Kansas, with Lyle S. DeWitt the chief inspector.

Oklahoma Contracting Corporation, 1210 Mercantile Bank Building, Dallas, Texas, reports the following contracts:

Twenty-three miles of 30-in. for Transcontinental Gas Pipe Line Corporation, from Edgewater to Elizabeth, New Jersey. Louis Visentine is the superintendent and Ernest F. Smith paymaster. The office and warehouse are in Edgewater, New Jersey. This job is under way.

For Salt Lake Pipe Line Company, 63 miles of 8-in. from Mountain Home to Boise, Idaho. Aldress Kilgore is superintendent and R. F. Mueller paymaster. The office and warehouse are at Mountain Home, Idaho. Construction began May 1.

For Tennessee Gas Transmission Company, 103 miles of 30-in. and 26-in. loops from Premont to the vicinity of El Campo, Texas. M. E. Shiflett is superintendent and Joe Freeman paymaster. This job was started April 1.

Construction will begin about June 1 on 85 miles of 18-in. for Portland Pipe Line Company from Portland, Maine, to Gorham, New Hampshire. H. A. Wylie will be superintendent and Lisle W. Chambers paymaster. Office and warehouse have been established at Westbrook, Maine.

Also to begin about June 1 is the laying of 91 miles of 30-in. for Tennessee Gas Transmission Company from Holly Springs, Mississippi, south. Raymond Law will be the superintendent and Gene Gohring paymaster. The office and warehouse are at Holly Springs, Mississippi.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas (stringing contractors), report the following jobs:

For H. C. Price Company (Tennessee Gas Transmission Company line), 400 miles of 26-in. in Ohio, Pennsylvania, and New York, and 177 miles of 30-in. in Kentucky and Tennessee.

For Eastern Construction Company (Mid-Valley system), 75 miles of 22-in.

For Oklahoma Contracting Corporation (Salt Lake Pipe Line Company), 60 miles of 8-in. in Idaho.

For Conyes Construction Company (Montana-Dakota Utilities Company line), 340 miles of 12-in. in Wyoming and Montana.

For El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

For Britton Construction Company (Tennessee Gas Transmission Company), 35 miles of 16-in. in Pennsylvania.

Carl H. Dunn, Burkburnett Building, Fort Worth, Texas, expects to complete about the middle of May 33 miles of 10-in. for the Texas-New Mexico Pipe Line Company in West Texas. The line is being laid from the Basin System station just out of Colorado City to the Kent County line. C. C. "Happy" White is superintendent in charge and headquarters are at Colorado City.

Morrison Knudsen Company, Inc., Macco Corporation, and **Bechtel Corporation,** San Francisco, California, have the contract to lay 140 miles of 8-in. line from Boise, Idaho, to Baker, Oregon, for Salt Lake Pipeline Company, to carry refined products.

Modern Welding Company, Inc., Owensboro, Kentucky, is working on 16 miles of 2, 6, 8, 10, and 12-in. at Whitehaven, Tennessee, for the Whitehaven Utility Commission. The company recently completed 32 miles at Frayser, Tennessee, for the Memphis Suburban Utilities, 5 miles at Richmond, Kentucky, for Richmond Water and Gas Company, 4 miles for the Moreland, Kentucky, Utility Board (4 and 6-in. lines connecting the Tennessee Gas Transmission Company with the city of Moreland), and ½ mile of additions to the Owensboro city system for Western Kentucky Gas Company.

Percy Jones, Inc., P.O. Box 1083, Oklahoma City, Oklahoma (stringing contractors), is hauling and stringing 49 miles of 8-in. pipe between West Tulsa and Cushing, Oklahoma, on the Great Lakes Pipe Line Company job. Trojan Construction Company is the general contractor. The company recently completed the stringing of 52 miles of 4, 6, 8, and 10-in. near Ulysses, Kansas, used in the construction of a gathering system for Cities Service Gas Company by R & H Construction Company.

Bechtel-Price-Conyes, 220 Bush Street, San Francisco, California, is working in the vicinity of Barstow, California, on the Pacific Gas and Electric Company line, which is 506 miles of 34-in. extending from Topock, Arizona, to Milpitas, California. A double-ending plant is in operation at Barstow. R. L. Bowman is general superintendent of the project and M. V. Scott is manager of the mainline office at Barstow. The mailing address is P.O. Box 698. Steve Valline is manager of the project office at San Francisco.

Bechtel Corporation, Somastic Division, 220 Bush Street, San Francisco, California, is applying Somastic coating to 28 miles of pipe at its Watson, California, plant. Fourteen miles of 14-in. and 10 miles of 16-in. are being coated for Richfield Oil Corporation. Four miles will be laid (14-in.) between the company's Los Angeles refinery and Long Beach Harbor. The remainder will be used between Newhall and the Wheeler station. Four miles of 6-in. is being coated for Wilshire Oil Company, which will replace pipe in highly corrosive areas between West Newport and Santa Fe Springs.

Parkhill Truck Company, P.O. Box 1856, Tulsa, Oklahoma (stringing contractor), has contracted the following jobs:

For Anderson Brothers Construction Company, 240 miles between Duluth, Minnesota, and Gretna, Manitoba, Canada, on Interprovincial Pipe Line Company line.

For Smith Contracting Corporation, 196 miles of 30-in. in Virginia on Transcontinental Gas Pipe Line Corporation system.

For Britton Construction Company, 109 miles of 22-in. in Kentucky on Mid-Valley Pipeline Company system.

For Mahoney Contracting Company, 120 miles of 20-in. from the Ohio River to Lima, Ohio, on Mid-Valley line.

For Morrison Knudsen Company, Inc., Macco Corporation, and Bechtel Corporation, 120 miles of 8-in. between Boise, Idaho, and Baker, Oregon, on Salt Lake Pipe Line Company line.

For Pacific Pipe and Engineers, Ltd., 120 miles of 8-in. from Baker, Oregon, to Pasco, Washington, on Salt Lake system.

For Deaton and Sons, 105 miles of 12-in. on Montana Power Company line from Bozeman to Butte.

For Midwestern Constructors, Inc., 100 miles of 26-in., in Nebraska, Iowa, and Minnesota, on Northern Natural Gas Company system.

For Mary Construction Company, 100 miles of 26-in., in Nebraska, Iowa, and Minnesota on Northern Natural Gas Company system.

For Pacific Pipe and Engineers, 234 miles of 12-in. between Tulsa, Oklahoma, and Kansas City, Missouri, on Great Lakes Pipe Line Company system.

Britton Construction Company, Weatherford, Texas, has been under way since April 1 on construction of 111 miles of 22-in. pipe line for Mid-Valley Pipeline Company between Russellville and Elizabethtown, Kentucky. Personnel include: H. R. Britton, manager; Fred N. Peters, spread superintendent; E. Howard Smith, office manager, and Ed Simmons, welding foreman. The field office is at Russellville.

H. C. Price Company, P.O. Box 1111, Bartlesville, Oklahoma, has four spreads at work on a total of 220 miles of 26-in. for Tennessee Gas Transmission Company. Spread 1 began work May 1 under the superintendency of G. A. Reutzel and is laying 63 miles southwestward from the south bank of the Mahoning River, near Youngstown, Ohio. Headquarters are at Columbiana, Ohio. Spread 2 is laying 63 miles northeastward from the north bank of the Muskingum River. This spread began work April 17 and is in charge of R. K. Shivel. The field office is at Zanesville, Ohio. Spread 3 is working southwestward from the south bank of the Muskingum River 47 miles. Headquarters are at McConnelsville, Ohio, with W. B. Williams the superintendent. Work began April 17. Spread 4 also is laying 47 miles, extending northeastward from the north bank of the Ohio River. C. R. Ice is the superitendent and headquarters are at Sciotoville, Ohio. This spread also "kicked off" April 17. Beginning in August of this year the contractor will lay the balance of the project, consisting of 373 miles from the north bank of the Ohio River to a point near Buffalo, New York.

Texas-Southern Contracting Company, 804 Dan Waggoner Building, Fort-Worth, Texas, is hoping to get started by June 1 on Section D for Transcontinental Gas Pipe Line Corporation, 91.7 miles of 30-in. from a point near Deweyville, Texas, to Porters, Texas. Lack of pipe is the delaying factor. The company also has contracted to install two river crossings on the system, one of the Trinity near Liberty, and the other of the Sabine near Deweyville in Newton County.

Smith Contracting Corporation, 1410 Fort Worth National Bank Building, Fort Worth, Texas, is making good progress on the 196 miles of 30-in. it is laying for Transcontinental Gas Pipe Line Corporation between Chatham, Virginia, and the Potomac River. The field office for Section 10 is at Altavista, with C. C. Craig spread superintendent and Ben L. Mapes office manager. An office was recently opened at Charlottesville, Virginia, for Spread 11. H. J. McAdams is office manager, but the spread superintendent has not yet been assigned.

Right-of-way is being made and road crossings bored on 108 miles of 16-in. between Baytown and Provident, Texas, for Texas Eastern Transmission Corporation. Pipe laying is not expected to begin until July due to inability to obtain pipe. Brown and Root are acting as agents for the job.

Latex Construction Company, 2707 Ferndale Place, Houston, Texas, announces the following work:

For Mid-Valley Pipeline Company, 41 miles of 20-in. crude oil line from Haynesville, Louisiana, to the Red River near Benton, Louisiana. Work began April 15, with headquarters at Haynesville.

For Mid-Valley, 18 miles of 12-in. crude oil line near Lake Providence, Louisiana. This work is to complete the lateral from Delhi to the main line at the Mississippi River. W. H. Hayes, superintendent; J. C. Strickler, office manager; headquarters, Lake Providence, Louisiana. Preliminary work began April 3.

For Tennessee Gas Transmission Company, 123 miles of 30-in. gas line. Ninety miles of this work is from vicinity of West Monroe, Louisiana, to a point near Many, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler, and J. B. Stoddard, office; initial headquarters Jonesboro, Louisiana. Preliminary work began in April. The second section of this job is 33 miles from Jones, Louisiana, to the Mississippi River to be done later.

For Tennessee Gas, 54 miles of 16-in. and 12-in. from Kinder, Louisiana, to Grand Chenier, Louisiana. F. A. Silar, superintendent; W. A. Briley, assistant superintendent; C. V. Oliver, office manager; headquarters, Kinder, Louisiana.

For Tennessee Gas, 95 miles of 20-in. from Natchitoches, Louisiana, to Kinder, Louisiana. F. A. Silar, superintendent; W. A. Briley, assistant superintendent; C. V. Oliver, office manager. Preliminary work to begin this month but pipe expected about July 1.

For Transcontinental Gas Pipe Line Corporation, 85 miles of 4-in. to 14-in. gas gathering system in South Louisiana. One spread began work April 1. J. B. Latham, superintendent; W. E. Bayles, office manager; headquarters, Vinton, Louisiana. A second spread will start as soon as pipe is available.

N. A. Saigh Company, Suite 531 Majestic Building, San Antonio, Texas, opened field headquarters at Athens and Cleveland, Tennessee, on April 20 from which to lay 150 miles of 12-in. for the East Tennessee Natural Gas Company. The line will extend from Athens to Tullohoma via Chattanooga. Headquarters later will be established at Chattanooga. Carl Doyle is general superintendent, James E. Gray manager of field offices, and Robert E. Floyd Spread 1 foreman.

Eastern Construction Company, 1801 Mercantile Bank Building, Dallas, Texas, is now making good progress on the Mid-Valley Pipeline Company job and to April 20 had laid 33 miles of pipe. The section being laid consists of 155 miles of 22-in. between Hornsby, Tennessee, and Russellville, Kentucky. Fred Byers is general superintendent. The main field office is at Waverly where J. W. Arthur is office manager. Two spread offices have been established. At Clarksville, L. A. Stewart is spread foreman and J. D. Jones office manager. At Lexington, Cliff Simmons is spread foreman and Fred Harwell office manager.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, is at work on 86 miles of 26-in. for Transcontinental Gas Pipe Line Corporation, between Danielsville, Georgia, and the Saluda River in South Carolina. Work is scheduled to begin this month (May) on the Interprovincial Pipe Line Company job. Williams Brothers have contracted to lay the pipe from Regina to Gretna on this crude oil system.

Anderson Brothers Construction Company, 707 North Drennan Street, Houston, Texas, will complete this month (May) the 193 miles of 18-in. crude oil line it is laying for Humble Pipe Line Company from Satsuma, Texas, in the Gulf Coast area, to a point between Fredericksburg and Llano, on Humble's new West Texas-Gulf Coast line.

Scheduled to start this month is the laying of Interprovincial Pipe Line Company's line between Gretna and Superior, as a part of the 1150-mile line from Edmonton, Alberta, Canada, to Superior, Wisconsin.

Associated Pipe Line Contractors, Inc., 4001 Homestead Road, Houston, Texas, will begin laying this month a part of the line between Portland and Montreal on the Portland Pipe Line Company and Montreal Pipe Line Company systems. The two companies are paralleling their existing 12-in. line with an 18-in. Associated is now laying 74 miles of pipe on the Transcontinental Gas Pipe Line Corporation system, from the Potomac River in Virginia to the Susquehanna River in Pennsylvania.

Mahoney Contracting Company, Hersee Building, Mt. Pleasant, Michigan, is constructing 120 miles of 20-in. for Mid-Valley Pipeline Company. The section is from the north bank of the Ohio River to Lima, Ohio, terminus of the system. This work is in progress and a field office has been opened at Hamilton, Ohio. Harold Finnerty spread foreman. Don MacDonald is in charge of the office.

Banister Corporation, Ltd., 609 Northern Hardware Building, Edmonton, Alberta, Canada, reports that work has been scheduled this year for Imperial Oil, Ltd., producing department, The Imperial Pipe Line Company, Ltd., British American Oil Company, The Texas Company, Royalite, and several other companies. The contractor installs flow and gathering lines up to 10 in. in diameter.

Wunderlich and Griffis Pipe Construction Company, 745 Riverside Drive, Tulsa, Oklahoma, is laying the pipe on Spreads Nos. 13 and 14 on the Transcontinental Gas Pipe Line Corporation system. Spread No. 13 extends from the Susquehanna River to the Delaware River, a total of 84 miles. Spread No. 14 is from the Delaware River to the Hackensack River in New Jersey, a distance of 41 miles.

Deaton and Sons, Inc., P.O. Box 2928, Odessa, Texas, is laying 83 miles of 12¾-in. from Bozeman to Butte, Montana, for Montana Power Company. W. F. Deaton is spread superintendent, H. H. Franklin office manager, and S. M. Scalf pipe foreman. When this job is completed 21 miles of 12¾-in. pipe will be laid for the same company from Billings, Montana, to the Wyoming border.

H. L. Gentry Construction Company, 921 Michigan Avenue, Jackson, Michigan, has begun work on 90 miles of 22-in. in the Mid-Valley Pipeline Company system. The section is between Mt. Washington and Hebron, Kentucky. The field office is at Warsaw, Kentucky. Frank Morris is general superintendent and James Mitchell spread superintendent.

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CLEVELAND TRENCHER in the suburbs of an Illinois city, cutting trench for 16 miles of 20" to 24" line.

When you invest in CLEVELAND TRENCHERS for all your trench excavation work you draw extra dividends in the form of steady, dependable schedule-beating performance and a faster pace for your pipe crews. CLEVELANDS extra power, wide range of transmission-controlled speed combinations, and tough all-welded construction make short work of the worst digging conditions, while CLEVELAND "unit" assemblies allow necessary repairs to be made quickly and easily in the field. CLEVELANDS correct wheel-type design gives you cleaner and better trench, plus the superior flexibility that permits cutting on or off the line without leaving "plugs". You need CLEVELAND "dividends" on your main, transmission, distribution, service and gathering line work. See your local distributor for the full story.

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NEWS

IRAA Asks for Equal Hydrocarbon Proration

The Independent Refiners Association of America has asked the Texas Railroad Commission to prorate all hydrocarbons on an equal basis. The IRAA stated that if all hydrocarbons were given the same proration treatment, the wasteful practice of flaring butane and propane could be corrected and production could be prorated to market demand.

The IRAA showed the depressed conditions of the independent refineries and the downward trend of crude oil production in the state, as contrasted with the upward trends and all-time records of the gas industry. In order for the state to regain its lost markets and to stop great losses in its revenue, the IRAA recommended a formula whereby gas would be given the same proration treatment as crude oil to the extent that gas supply, like crude oil, would also be reduced to 26 per cent of its 1948 rate.

Natural Gas Firms' Revenue Up 13.6 Per Cent in January

Operating revenues of natural gas companies increased 13.6 per cent in January over the same month in 1949, according to the Federal Power Commission. Revenues totaled $116,289,192, compared with $102,403,684 reported for the same month last year.

Gas utility operating income for January was up 9 per cent over January, 1949, the FPC reported, with net income for the month more than $2,000,000 above last January. Gas operating revenue deductions increased 14.9 per cent. Of this total, operating expenses were up 15.6 per cent; depreciation up 13.6 per cent, and taxes increased 12.3 per cent, FPC stated.

Gas sales were up 13.7 per cent over January, 1949, making a total of 176,177,000,000 cu ft sold in January.

Procurement Bids Available

Copies of complete bids listed on military and civilian procurement contracts have been put on open file in its 14 regional offices for anyone to see, the Department of Commerce has announced. Synopsis will include a brief but adequate description of the item to be procured, quantity required, invitation number, and place and date of bid opening or issuance. Purpose of this new program is to speed procurement information, giving American businessmen equal opportunities to compete for contracts.

Brantly Speaks Before Nomads. Ned Brantly spoke on foreign oil at recent meeting of the Dallas-Fort Worth Nomads. Foreign guests attending were J. M. De La Garza, Francisco Gomez, and Juan Cortina of Mexico, and M. R. Garrison of Rio de Janeiro. Included among the out-of-town guests were Neil Mallon and J. B. O'Connor of Cleveland and B. Reinhold and Ott Hammer of Los Angeles.

Lube Export End Seen

If the present trend continues, lubricating oil experts from the United States would cease by 1953, in the opinion of H. A. Logan, director of the Pennsylvania Grade Crude Oil Association. Speaking before a meeting of the directors of the Association, Logan stated that from all indications, various segments of the oil industry will join together and urge that no Marshall aid funds be used for expansion of foreign oil refining facilities beyond their pre-war size. He added that exports of lubricating oils from this country in 1949 amounted to 35,000 bbl daily, or one-quarter of the average daily production of 140,000 bbl.

Injury Record Down

The improvement in the injury record of the petroleum industry in 1949 over 1948, resulted in the lowest frequency and severity rates in the history of organized petroleum safety. Based on the experience of 263 oil companies, including subsidiaries, employing 478,583 persons, the frequency rate for 1949 was 10.54, 14 per cent less than was reported for 1948. The past year is the fourth consecutive one in which a decrease in frequency rate was noted.

National Oil Moves Office

National Oil Company has moved its headquarters office to the building at 6th and Grand in Los Angeles, California. The structure, formerly known as the Edwards and Wildey Building, has been renamed the National Oil Building.

Price Adjustments for Oil Made in Scattered Areas

Higher prices on low gravity crude oils have been set by several companies in the East. In Canada, Imperial Oil Company, Ltd., has announced price adjustments to compensate for higher freight rates that became effective March 23.

Esso Standard Oil Company has restored prices of bunker "C" fuel oil that were in effect prior to the 15-cent a barrel reduction made on March 1. This would make its New York barge price $2.05 and the Gulf Coast cargo price $1.65 a barrel. Rock Island Oil and Refining Company has announced an 8-cent a barrel rise in the prices, setting the new schedule at $2.54 for 35 gravity crude. In Mississippi, however, Gulf Refining Company cut its low gravity crude oil price to $1.15 a barrel in the Baxterville field. At the same time the company increased its take to about double that of last year.

Taylor Sees Possible California Price Cut

Crude oil prices may have to be cut and production lowered in California, according to Reese H. Taylor, president of Union Oil Company of California. Through closing-in of approximately 135,000 bbl daily of crude production by the California industry and plans to ship more than 10,000,000 bbl of heavy fuel oil east at low prices this year, Taylor believes that the supply on the West Coast will balance with demand during 1950. He added, however, that existing West Coast inventories are still excessive by at least 25,000,000 bbl.

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gives you extra speed, mobility . . . ONE-MAN HANDLING

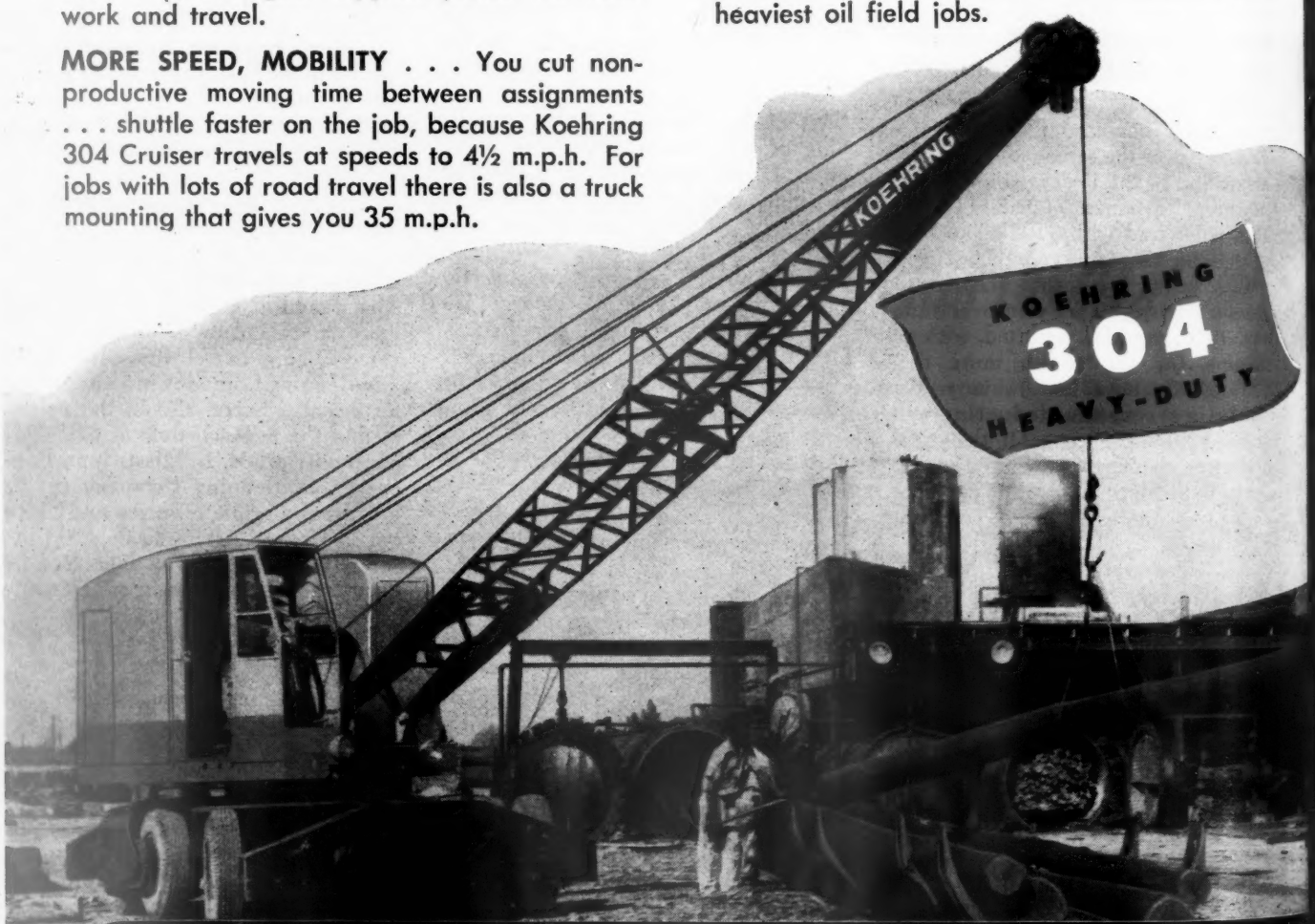
On jobs of short duration, unloading cars, setting steel, handling pipes, tanks, etc. . . . anywhere travel time is an important percentage of job duration, Koehring 304 Cruiser Crane cuts time and handling costs.

ONE-MAN HANDLING . . . Operator controls both crane work and travel from cab . . . means less man-hours to get job done . . . lower cost per lift. Crane engine supplies power for both work and travel.

MORE SPEED, MOBILITY . . . You cut non-productive moving time between assignments . . . shuttle faster on the job, because Koehring 304 Cruiser travels at speeds to 4½ m.p.h. For jobs with lots of road travel there is also a truck mounting that gives you 35 m.p.h.

EXTRA LIFT CAPACITY . . . extra stability of rubber-tired mounting increases 304's maximum lifting capacity from 13.9 tons crawler rating to 25 tons on either cruiser or truck mounting.

That's only a few of the reasons why it pays to use Koehring rubber-tired Cranes, wherever oil field operating conditions permit. Your local Koehring distributor can show you many more time and money-saving advantages. Ask him, too, about Koehring 205 available on crawlers or truck mounting. Other Koehring sizes: Big 605 and 1005, both crawler-mounted, for your heaviest oil field jobs.



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and SMALL oil-field jobs.....

KWIK-MIX 3½-S.... utility size DANDIE

- **Pays off on scattered, small-quantity mixing assignments . . . gives you high-quality concrete mixed fast, at low cost anywhere on your property.**
- **Portable as a wheelbarrow . . . balanced light weight and handy push-down towpole provide safe one-man handling on the job . . . easy towing.**
- **Large drum opening, low shoveling height of only 3½' mean fast, easy charging . . . more concrete mixed per shift.**
- **Convenient end discharge eliminates backing and turning loaded wheelbarrow . . . gets barrow loaded and on its way with ½ the usual effort.**

For consistent savings on your major concrete-laying projects, check bigger size Kwik-Mix 6-S . . . 11-S . . . 16-S DANDIES*.

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fully-powered Moto-Bug ups output per man-hour...

On your small materials-handling tasks, you can get 3 to 4 times more production per man-hour with Kwik-Mix 4 h.p. Moto-Bug. Here's why. It hauls 4 times as much (10 cu. ft.) as ordinary hand wheelbarrow . . . makes more trips per hour because it's *fully* powered, travels 1½ to 4 m.p.h. forward and reverse. No pushing . . . no pulling . . . no end-of-day "slow-down". For complete facts on its controlled gravity dump . . . positive steer arrangement . . . *standard make* 4-cycle gas engine . . . and 1200 lb. capacity flat-bed platform, see your local Kwik-Mix distributor, or send for bulletin.

KKM923-rev.

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KOEHRING SUBSIDIARY

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Please send bulletins on following DANDIE concrete mixers: ☐ 3½-S ☐ 11-S ☐ 6-S ☐ 16-S

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COMPANY.....

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Also send ☐ bulletin ☐ price information on low-cost MOTO-BUG.

NEWS

Oil Demand Increases In Marshall Plan Countries

Consumption of petroleum products in the Marshall Plan countries has expanded rapidly in the past two years, the Economic Cooperation Administration reports, but dollar expense of exports is decreasing. Imports by American companies, if expressed in refined product equivalents, are expected to be seven per cent less by volume in 1951, than in 1948, but non-dollar imports will be 37 per cent larger. ECA officials estimated the cost of dollar oil imports would decline from $440,000,000 in the fiscal year 1950 to $375,000,000 in the 1951 fiscal year, although the volume in refined product equivalents would remain about equal. The decline in cost can be attributed partly to a continuing shift from refined product imports to crude oil imports and partly to an over-all decline in prices.

Procurement authorizations through February, for crude oil and petroleum products for Marshall Plan countries, including French overseas territories, which were allowed $3,545,000, amounted to about $808,000,000. Of this total, $252,000,000 came from the U. S.; $256,000,000 from other Western Hemisphere countries, and $300,000,000 from the Middle East and other sources. Over 80 companies have participated in shipments.

CONDOR Increases Capital

At the general meeting held in the registered office of CONDOR S.p.A. per l'Industria Petrolifera e Chimica in Rome recently, it was decided to increase the company's capital to three thousand million lire. The new capital will enable the company to finance the construction work now in progress; namely, 1. A sea-port installation at Genoa and a pipe line for the transport of crude oil from Genoa to Rho, near Milan, with an annual capacity of about 12,000,000 bbl (1.5 million tons) of crude oil.

2. A refinery at Rho on the northwesterly outskirts of Milan with a capacity of more than 1,000,000 tons per annum.

The new Board of CONDOR is as follows: Gualtiero de Fischel, Felice Guarneri, Calogero Ingoglia, F. Kind, C. Miranda, Bernardino Nogara, Carlo Pesenti, Massimo Spada, Uff. Michele Sulfiña, and Giorgio Valerio.

The post of chairman has not yet been filled, but Dr. F. Kind has been elected vice chairman.

Proved Crude Oil Reserves Reach All-time High in 1949

Proved reserves of crude oil and natural gas scored another major increase in 1949, reaching new all time peaks and enhancing the internal security and strength of the U. S.

This was announced by the American Petroleum Institute and the American Gas Association in a joint report on the results of the near-record breaking rate of petroleum exploration in the 12-month period ending December 31, 1949.

Proved reserves of crude oil and natural gas liquids (condensates, natural gasoline and liquefied petroleum gases) were estimated at 28.3 billion barrels at the close of 1949, an increase of 1.5 billion barrels over the preceding year's total of 26.8 billion barrels.

Proved reserves of natural gas were estimated at 180 trillion cubic feet. This is an increase of 6.5 trillion cubic feet over 1948's year-end total of 173.8 trillion cubic feet.

Production of crude oil and natural gas liquids in 1949 was estimated at 2,017,347,000 bbl, a drop of 168,000,000 bbl under 1948's record-breaking total of 2,186,197,000 bbl.

Production of natural gas was estimated at 6.2 trillion cubic feet, an increase of 237 billion cubic feet over the preceding year.

The proved reserves were estimated by the reserves committees of the API and the AGA at a meeting in Colorado Springs, Colorado. The API group accounted for crude oil, and the AGA handled the natural gas estimates. Natural gas liquids were estimated by both committees.

A thumbnail picture of the reserves and production picture for 1948 and 1949 follows:

RESERVES	December 31, 1948	December 31, 1949 (barrels of 42 gallons)	Increase 1949 over 1948
Crude oil	23,280,444,000	24,649,489,000	1,369,045,000
Natural gas liquids	3,540,783,000	3,729,012,000	188,229,000
Total liquid hydrocarbons	26,821,227,000	28,378,501,000 (Thousands of Cubic Feet)	1,557,274,000
Natural gas	173,869,340,000	180,381,344,000	6,512,004,000

PRODUCTION	1948	1949	Increase 1949 over 1948
Crude oil	2,002,448,000	1,818,800,000	— 183,648,000
	183,749,000	198,547,000	14,798,000
Total liquid hydrocarbons	2,186,197,000	2,017,347,000	— 168,850,000
		(Thousands of cubic feet)	
Natural gas	6,007,628,000	6,245,041,000	237,413,000

The gas production figures indicated above are net after deducting only the amount of gas returned to reservoirs for cycling and pressure maintenance. They therefore include the gas put into underground storage.

Honor Medal Presented. James H. Pipkin, assistant to the chairman of the board of directors of The Texas Company, receives a 1949 honor medal of Freedoms Foundation Inc., Valley Forge, Pennsylvania, for "outstanding achievement in bringing about a better understanding of the American way of life." The medal was presented by Millard C. Faught, consultant to Freedoms Foundation. Pipkin received the medal for a speech given by him at Abilene, Texas entitled "Is Our Freedom in Danger."

Figure 1. **Lincoln® 200 amp. "Shield-Arc"** *engine driven arc welder doing overhead work on Transcontinental's new 30 inch line.*

New "Lincoln" Highway goes Underground

By **Harry K. Smith**

The Big Three Welding Equipment Co., Inc.

Houston, Texas

THE new Transcontinental Line may not be the famous Lincoln Route 30 but its 30″ pipe joints are being made with Lincoln electrodes and Lincoln "Shield-Arc" machines. This newest "Lincoln highway" is another of the score of similar cross country lines arc welded with Lincoln equipment.

Figure 2. **Diesel Engine Driven** *300 amp. Lincoln "Shield-Arcs" tractor mounted on contractor's mobile equipment for rough terrain.*

Stringer beads are being produced with Lincoln "Fleetweld 5" electrodes followed by filler beads of "Shield-Arc 85". The final or cap beads are made with "Fleetweld 5". All joints are pressure tested to 800 pounds per square inch and found free of porosity.

To simplify and speed the types of welding required on Transcontinental's work, maximum advantage is being taken of "Shield-Arc's" Dual Continuous Control. With this control, the operator sets the *right type* of arc as well as correct *arc intensity* to suit the type of work. For drag stringers where penetration is vital, he can set for a forceful, digging arc. On subsequent passes, where a longer arc is held, he can set the controls for fast welding with maximum deposition of weld metal.

GET THE FACTS

Write for Bulletins 312C and 1306 on Lincoln "Shield-Arc" Engine Driven Welders.

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LINCOLN

Heap Big Chiefs. Relationships between the pioneer Oklahomans and the pionee Magnolia Petroleum Company were further cemented in Oklahoma City recently when two Magnolia executives were made Indian Chiefs at the Oklahoma City Chamber of Commerce's "Magnolia Day" luncheon. Attending the luncheon, are: T. H. Marshall, chairman of the Oklahoma City oil and gas division and executive vice president of Anderson-Prichard Oil Company; J. L. Latimer, president of Magnolia, who was given the name "Mau-gau-om-keah," meaning Leader of Industry; Walace Hawkins, vice president and general counsel of Magnolia, who was named "Tau-kah-to-keah," meaning The Great Counselor; and Jasper Saunkeah, chief of the Kiowas, who bestowed the honors.

Unitization Raises Yield

Unitization of oil fields with full control of reservoir energy will result in recoveries of 70 per cent, John C. Calhoun, University of Oklahoma, has reported. Under unit operation, Calhoun stated, the entire field is treated and produced as a single lease.

Recovery of initial oil in the reservoir averaged as high as 25 to 30 per cent by natural flow and pumping, the faculty member stated, and with injection of gas into the reservoir to maintain pressures, 60 per cent of the oil may be obtained. With waterflooding as a last step, total recoveries may reach as high as 70 per cent.

Top Award for Safety

Oil Well Supply Company manufacturing plants have achieved an outstanding safety record over the past three years, Fred F. Murray, president, has stated. On March 1, 1950 this U. S. Steel subsidiary's four plants had amassed a total of almost five and one-half million man hours worked without a lost time accident.

Heading the list of individual plant records is Wilson-Snyder Manufacturing Division at Braddock, Pennsylvania, which has not had a lost time accident in nearly five years. Imperial Works at Oil City, has not had a lost time accident in over 15 months. Witte Engine Works Division at Kansas City, Missouri, recently was presented the national safety group's Award of Honor for one million hours without a lost time accident.

Socony Renews 5 Fellowships

Renewal of five fellowships has been announced by the Socony-Vacuum Oil Company, Inc., as part of its program for 20 fellowships in colleges and universities during the 1950-51 academic season. The total represents 19 renewals and one new fellowship. In each case the fellowship carries an award of $2000.

Enough Crude for Europe

Adequate crude oil supplies will be available for refineries under construction and planned for Europe is the belief of Howard W. Page, Anglo American Oil Company, Ltd. He stated that further substantial developments of crude oil production in the Middle East are indicated, with the largest increase coming from Iraq.

design

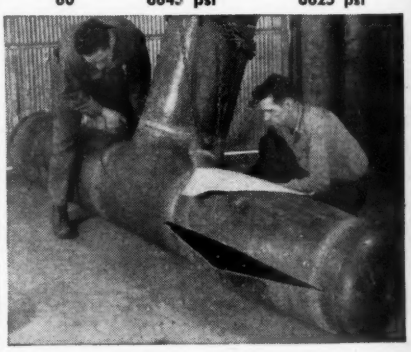
MAKES ALL THE DIFFERENCE IN WELDING TEES, TOO

When seamless drawn welding tees were introduced some 17 years ago, they represented a great advance over cut-and-welded intersections. Even so, they still had certain inherent weaknesses. Their design was unstable under high internal pressure and bulging resulted at the flat spots of the side walls. The relatively weak crotch area, carrying an unequal share of the load, usually gave way first in bursting tests. To compensate, tees were made excessively heavy.

Tube Turns research engineers developed a new welding tee design based on the sphere, nature's strongest form for resistance to internal pressure. This shape, with necessary modifications, became the basis for an entirely new welding tee design.

In the Tube-Turn barrel-type tee, the internal pressure load is carried largely in direct tension. And, in bursting tests involving the old and new design, it proved capable of withstanding 22% more pressure before yielding. It is at least 25% stronger than the code (ASA B16.9) requires, as evidenced by these test results on 6" tees:

	BURSTING PRESSURE	
Schedule	ASA B16.9 Required	Test Minimum
40	4440 psi	5950 psi
80	6845 psi	8625 psi



Result of typical hydrostatic bursting test conducted in the Tube Turns research laboratory. The pipe itself split wide open under the terrific pressure applied; the new Tube-Turn welding tee is undamaged. Micrometer checks reveal no evidence of yielding or distortion.

FREE BOOKLET

Write for your free copy of "Research", a booklet reporting results of cyclic tests being conducted by Tube Turns engineers on the fatigue life of piping assemblies. Well illustrated. Contains valuable information on relative fatigue life of welding elbows, mitre bends, various types of flanges.

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TUBE TURNS, INC.

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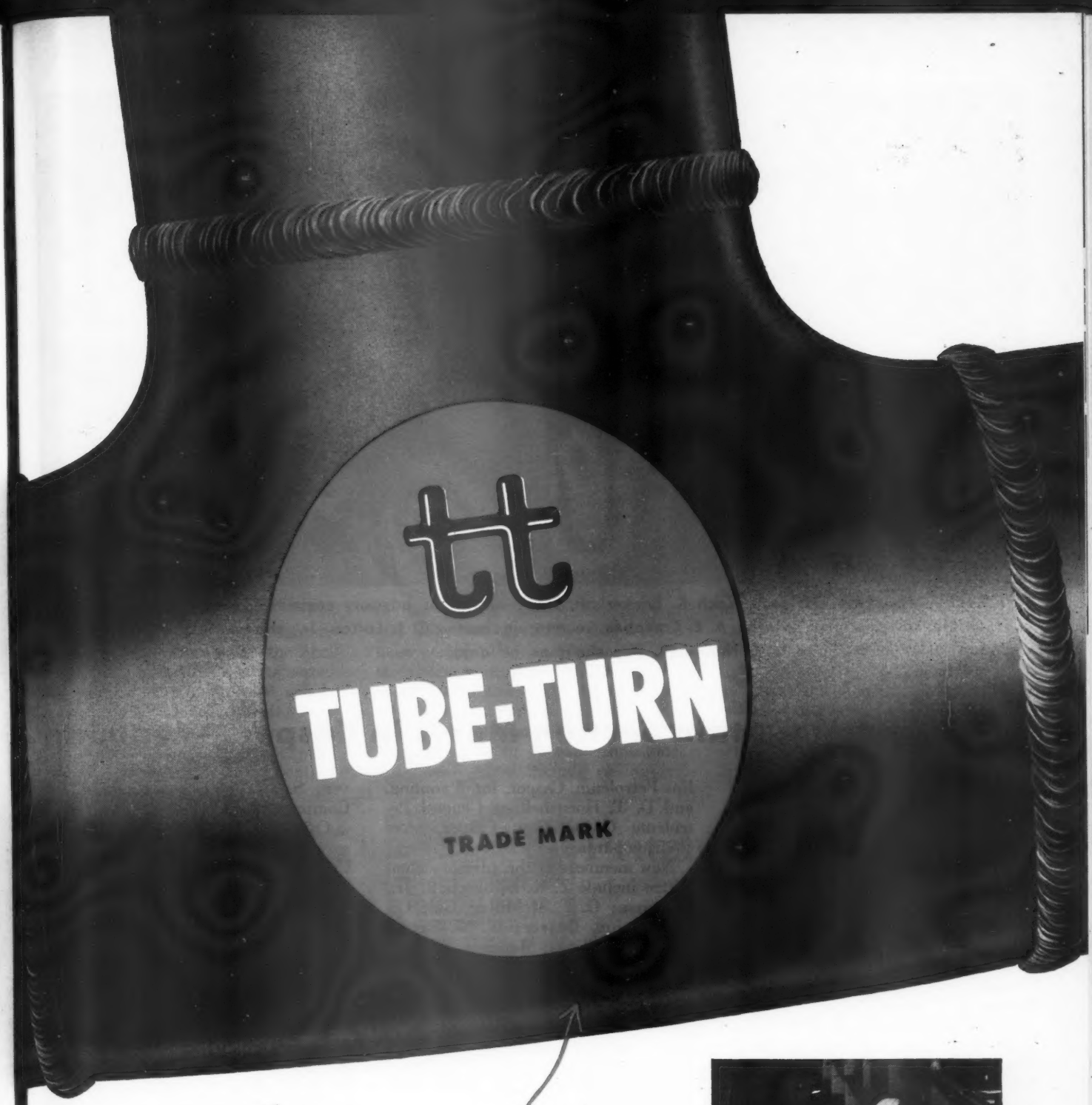

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API Rocky Mountain Officers: Zach K. Brinkerhoff, Jr., chairman of advisory committee and outgoing president; C. H. Griffin, vice chairman at large; A. E. Campbell, secretary-treasurer; C. L. Larson, Jr., chairman; W. P. Tallant, vice-chairman for Wyoming, and D. T. Hoenshell, vice chairman at large.

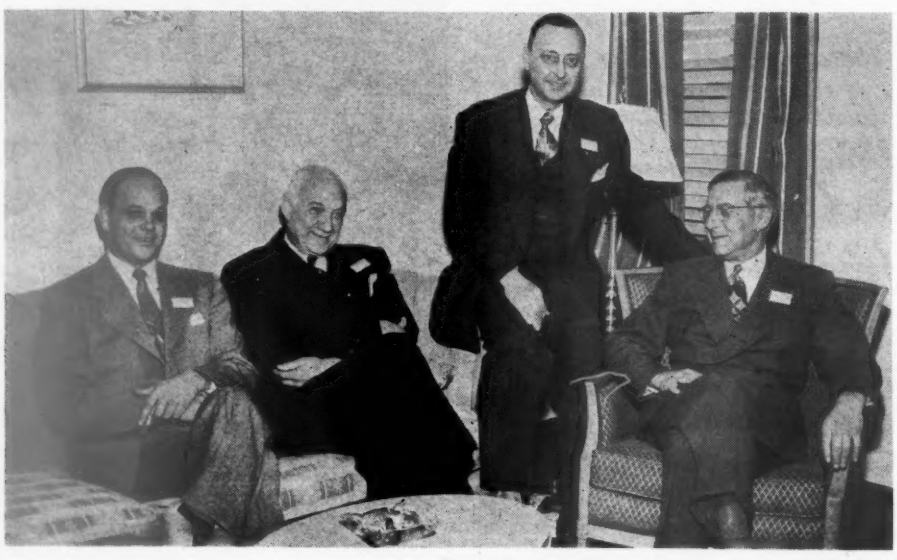
API Rocky Mountain Section Meets in Casper, Wyoming

C. L. Larson, Jr., Stanolind Oil and Gas Company, Casper, Wyoming, was elected chairman of the Rocky Mountain district, American Petroleum Institute division of production at the closing sessions of the district meeting held in Casper recently. He succeeded Z. K. Brinkerhoff, Jr., Brinkerhoff Drilling, Casper. A. E. Campbell, Seaboard Oil Company, Casper, was chosen secretary-treasurer.

Vice-chairmen elected were: Rex Davis, Carter Oil, Cutbank, for Montana; E. P. Tallant, Union Oil, Denver, for Colorado; C. H. Griffin, Phillips Petroleum, Casper, for Wyoming, and D. T. Hoenshell of General Petroleum Corporation, Casper, vice-chairman-at-large.

New members of the advisory committee include Z. K. Brinkerhoff, Jr., chairman; G. F. McMillan, Gulf Oil Corporation, Denver; W. M. Saxon, Pure Oil, Billings, Montana; Charles A. Pickett, The California Company, Denver; Claude E. Peavy, Phillips Petroleum Company, Salt Lake, Utah; Paul Kartzke, Shell Oil, Casper; William Jack, Rocky Mountain Oil and Gas Association, Casper; J. P. Moroney, Sinclair Oil Corporation, Denver; S. J. Lintzenich, Hughes Tool Company, Casper.

Carry-over members of the advisory committee are: J. C. Johnston, Continental Oil, H. H. Arnold, The Texas Company, C. L. Cooksey, Carter Oil, James Donoghue, The Mackinnie Oil and Drilling Company, Fred M. Manning, Jr., Fred M. Manning, Inc., D. R. Murphy, Mountain Producers Corporation, all of Denver: Richard Armstrong, Oil Well Supply. A. F. Barrett, General Petroleum Corporation, James R. Chapman, Continental Supply, J. F. Cullen, Stanolind Oil and Gas Company, J. F. Deffeyes, Pacific Western Oil Company, H. B. Gernert, Trigood Oil, J. W. Gillespie, National Supply, H. H. Healy, Ohio Oil, M. A. Park, Jones and Laughlin Supply, M. E. Tate, Noble Drilling Corporation, all of Casper, and M. R. McArthur, Husky Refining, Cody. * * *



At a press conference during Casper meeting are Zach K. Brinkerhoff, Jr.; J. E. Brantly, president, Drilling and Exploration, Dallas; G. F. McMillan, Gulf Oil, Denver, chairman, Rocky Mountain Oil Industry Information, and Robert L. Minckler, president, General Petroleum, Los Angeles.

Leads in Safety Record

The manufacturing department of the Socony-Vacuum Oil Company, Inc., led the manufacturing departments of every other large oil company in the United States in safety during 1949, according to figures released recently by the National Safety Council. In addition, the Socony-Vacuum refinery at Paulsboro, New Jersey, was ranked as safest among the world's 13 largest refineries, with an average of one disabling injury per year for each 29 workers.

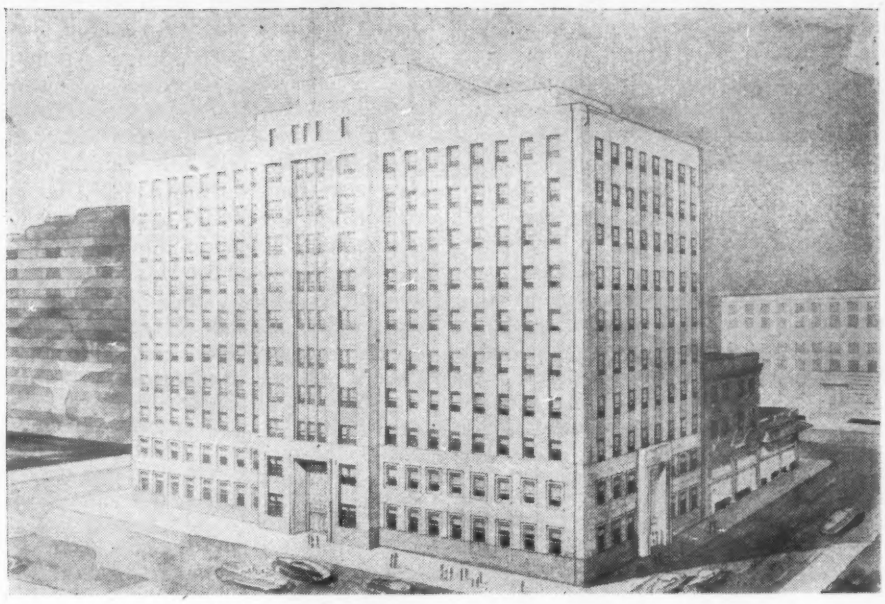
Gulf Honors 3766 Employees

Gulf Oil Corporation has awarded 3766 of its employees for completing 10 or additional 5-yr periods of service with the company. This raised the total number of company employees who have served for 10 or more years to 19,950, or 45 per cent of its personnel.

Shell Establishes Fellowship

A fellowship in petroleum engineering has been established by the Shell Union Oil Corporation and its associated companies. Appointment will be made for the period beginning September 1, 1950, and is for one academic year. Stipend is $1200 per year, plus $300 per year for equipment.

Atlantic Refining Completes New Southwest Headquarters



New southwest headquarters offices of The Atlantic Refining Company at 408 Bullington in Dallas, Texas have been completed. The $3,000,000, 10-story structure, which has been under construction since 1948, is of welded steel construction throughout, and completely air-conditioned. The outside facing is of Indiana limestone. Interior features include ceilings of accoustical tile, special flooring laid with light weight pumicefloor aggregate, and sound deadening rubber flooring in the corridors.

Four electronically controlled and coordinated self-service passenger elevators have been installed, each of which will travel at 700 ft per minute. Of the 274 offices in the building Atlantic will occupy 209.

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"Reversible," "Standard" and "Ideal" types in all sizes. *Jaws* are drop forged from special steel, are carefully milled, heat treated hardened and tested. The *Handles* are forged spring steel. The *Chains* are proof-tested to ⅔ catalog strength (1,200 lb. to 40,000 lb.). "Reversible" Jaws give double jaw life. "Standard" Jaws have extra bearing on the handle and forged-in chain guides. The "Ideal" Tongs have V shaped teeth for a sure grip on irregular shapes—fittings, etc.

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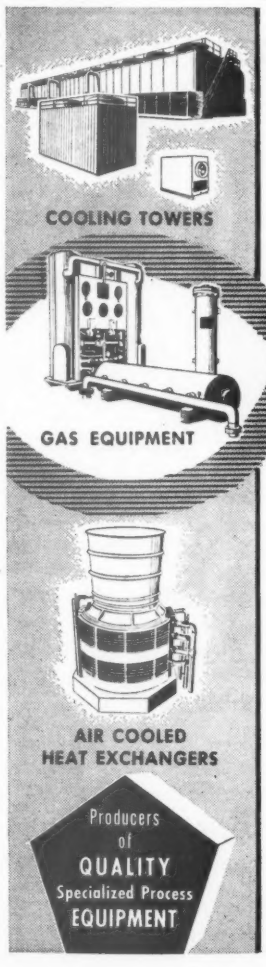

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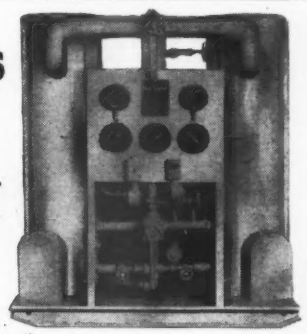

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Honor Long Service Employees

Fifty-seven employees of the Eastern division of Tide Water Associated Oil Company, including nine women, completed from 25 to 50 years of service during the past year. B. I. Graves, vice president in charge of the company's Eastern division, presented the company's diamond service emblem buttons to the eligible employees. Two New York office employees have the longest service in the group. They are Charles F. Watson, of Ridgewood, New Jersey, with 50 years of service, and James J. McGrath, of Bayonne, New Jersey, with 45 years.

Oil Flow Rate Boosted

For the second straight month, Texas has increased its crude oil production. The Railroad Commission has boosted the average daily allowable to 2,179,586 bbl per day, 58,241 bbl above the April figure. Fields are producing 18 days this month, one day more than during April. That is responsible for 36,241 of the advance.

Louisiana's production allowable also was increased for May. Maximum amount is 539,917 bbl, compared to April's 536,528 bbl. Most of the increase, it was announced, is to take care of the new production.

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Income Down in 1949; Lion Reports 1950 Up

Four different oil companies have reported lower net incomes in 1949, as compared with 1948. Creole Petroleum Corporation net income for the year amounted to $116,149,079, comparing with $198,655,625 in 1948. Crude oil production was reduced 7 per cent during the year 1949.

British-American Oil Company Ltd. and subsidiaries report a net profit of $7,879,684 for 1949, considerably lower than the $12,303,455 reported in 1948.

Consolidated net income of Tide Water Associated Oil Company and subsidiary companies for 1949 totaled $27,519,000. Comparable net income for the year 1948 was $39,387,000. Reduction in income, was due, company officials stated, to decrease in volume of sales, and sales prices of light and heavy fuel oils, kerosine, and certain type of lubricating oils.

Sinclair Oil Corporation shows in its annual report that consolidated earnings for the company were $54,073,338. In 1948 net earnings amounted to $81,048,602.

Imperial Oil Limited's earnings increased in 1949, $23,932,985, compared to $22,832,070 in 1948. Most significant development in the Canadian petroleum industry during the year was the growing production of crude oil that early in the year made it possible to elminate imports from the U. S. into the prairies.

In contrast Lion Oil Company led off the 1950 quarterly reports with the highest net income for any three-month's period in the history of the company. This year's income so far has amounted to $3,809,525.69, compared to the $2,222,778.92 reported for the same period last year.

Texas Pacific Coal and Oil Company, however, has reported a net income decrease for the first three months in 1950. The company reported net income of $1,315,381 compared to $1,659,159 in 1949.

Employee Suggestions Up

In slightly less than two years of operations, the Suggestion System of the Socony-Vacuum Oil Company, Inc., has awarded $46,691 to 1701 employees. The dollar savings to the company from these suggestions are estimated to have amounted to $161,032. A total of 9365 suggestions were received. During 1949, the first full year of the Socony-Vacuum Suggestions System, the number of awards rose from 630 to 1071; the number of suggestions per 100 employees increased from 18 to 19.

Only IN W-K-M VALVES

Seals in both open and closed position by parallel expansion directly across both seats . . . not by jamming or wedging into a tapered body and without any distortion whatever.

After reaching open or closed position, a slight movement of the handwheel expands this double tapered gate outwardly against the two over-size seats forming a perfect seal on both sides. Then, the first opposite movement of the wheel collapses the gate, away from the seats, sufficiently to allow the valve to be opened or closed without effort . . . against full rated pressure.

Chrome plated gates for resistance against corrosion add materially to the ease of operation of W-K-M Valves.

This is another of the several reasons why you may be sure that a W-K-M Valve will always effect a complete shut-off . . . will always open or close under full rated pressure.

PRESSURE SEAL BONNET

Requires no flanges — no studs and nuts. Self-Adjusting to pressure and temperature changes . . . instead of tending to push bonnet off, greater pressure gives tighter seal . . . considerably less area exposed to internal pressure.

PLUS THESE OTHER PROVED FEATURES

- Double roller thrust bearings on stem for ease of operation.
- Chrome-plated gates.
- Stem and thrust bearings may be withdrawn through top of bonnet for inspection or replacement.
- Precision ground threads on stem.
- Combination plastic-chevron packing —uses no gland or gland follower.

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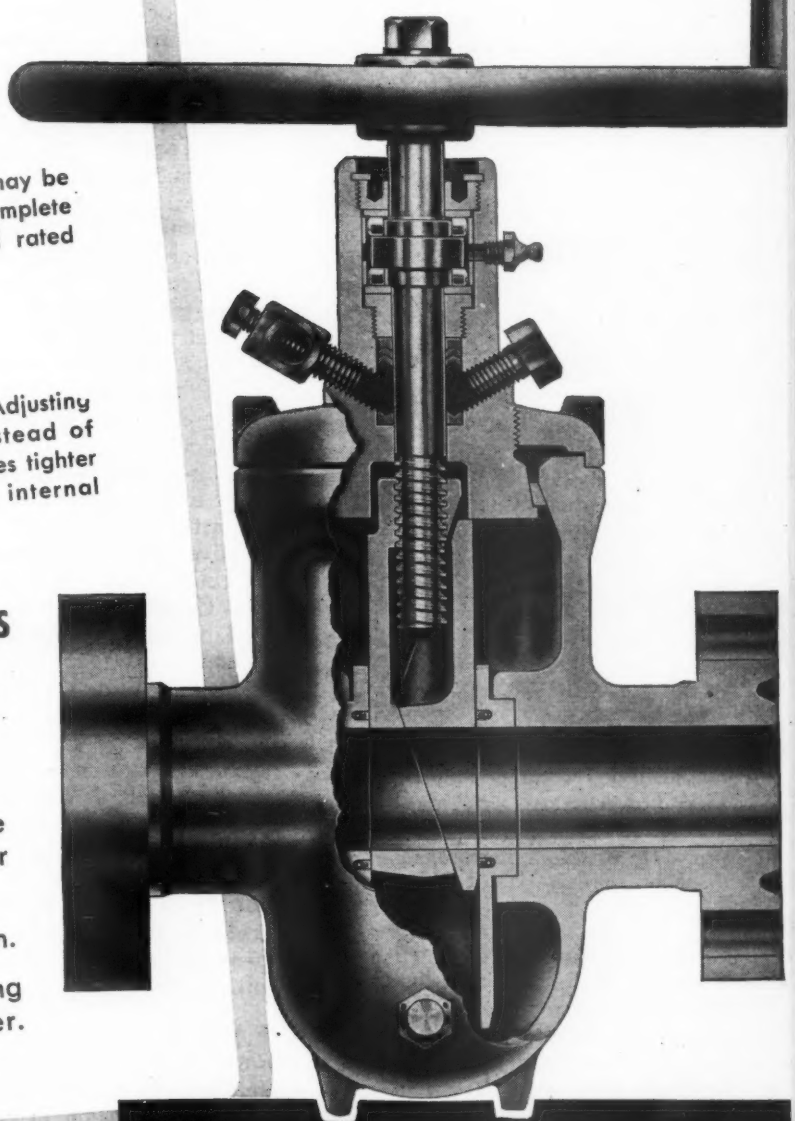

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PERSONALS

Frank M. Porter

Frank M. Porter of Oklahoma City became the 10th president of the American Petroleum Institute recently, succeeding **William R. Boyd, Jr.** of Teague, Texas, retired. Porter, 58, a native of Brooklyn, New York, is president and owner of the Fain-Porter Drilling Company of Oklahoma City, and has served as president of the Mid-Continent Oil and Gas Association for the past four years. **Baird H. Markham** was elected to membership on the board of directors. Markham will continue to serve as director of the American Petroleum Industries Committee, a post he has held for 17 years.

Porter's election to the API's top executive position was the unanimous action of the Institute's board of directors, according to W. Alton Jones, board chairman. Porter's was the only name submitted by the nominating committee, headed by Hines H. Baker, president of Humble Oil and Refining Company. He will assume the duties of his office at once and spend the majority of his time in New York at API headquarters. He will continue to maintain his residence in Oklahoma City, however, and will continue as head of the Fain-Porter Drilling Company. He will resign the presidency of the Mid-Continent Oil and Gas Association in due course, he said.

John Thomas O'Neil died in Los Angeles, California recently. O'Neil, whose interests were petroleum, sports, and philanthropy was identified at various times with the International Refining Company, Kevin-Sunburst, Montana, Wellington Oil Company in Texas and California, Santa Clara Oil Company in Texas, and the Far West Oil Company in Texas and Wyoming. He entered the oil business in Montana with a brother, Louis B. (Tip) O'Neil, and later became an independent operator in the Southwest, the Rocky Mountain region, and on the West Coast.

A great sportsman, O'Neil was prominent in the Olympic rugby events in Antwerp, Belgium in 1920 and again in Paris in 1924.

William R. Boyd, Jr., of Teague, Texas, **Major B. A. Hardey,** Shreveport, Louisiana, and **R. L. Wheelock,** Corsicana, Texas, have announced the formation of the firm of Boyd, Hardey & Wheelock. The firm was established to conduct activities and operations limited to the initiation and conduct of negotiations for the purchase or sale of oil or gas producing properties, and for the merger of oil or gas companies or individually owned oil or gas interests. The scope of the firm's activities and operations may later be enlarged.

Headquarters office of the firm will be in Teague, Texas, and Boyd will be the managing partner.

Boyd is a consulting attorney and petroleum-consultant-advisor. For 29 years he was an official of the American Petroleum Institute, in New York. After serving eight years as president of that organization he retired in November, 1949 and returned to his old home, Teague.

Hardey is an independent producer of oil and gas. He first engaged in the oil business as an employee of the Gulf Refiining Company's production department, afterward becoming executive vice president of subsidiaries of United Gas Company and Republic Gas Corporation. He served the State of Louisiana as Conservation Commissioner, and was for eight years chairman of the State Mineral Board. He is a former president of IPAA.

Wheelock is an independent producer. He is a member of the oil producing firm of Wheelock & Collins, and during the existence of the Texas Petroleum Council, served as its president. He is at present vice president for Production of the American Petroleum Institute and chairman of the general committee of its production division.

A. J. Hartman has been appointed assistant general manager of employee relations, **G. L. Scott,** manager of the personnel division of employee relations, and **W. B. Billock,** manager of the labor relations division of employee relations by Gulf Oil Corporation. All three men are stationed in the company's general offices at Pittsburgh, Pennsylavania.

J. D. Sanford, Rock Hill Oil, **Millard G. Sinclair,** independent operator, San Antonio; **Harold Decker,** Houston Oil, Houston, and **T. F. Grisham,** Grisham-Hunter Corporation, Abilene, Texas have been confirmed as new directors of the Independent Petroleum Association of America.

The new Texas directors were among 10 elected during a recent meeting of the association's executive committee in Washington, D. C. Six others elected were **Harold L. Woods,** Monroe, Lousiana; **F. H. Harrell, W. O. White,** Shreveport; **C. E. Skiles,** Mt. Carmel, Illinois; **Russell P. Johnson,** Olney, Ill., and **George E. Brimmer,** Cheyenne, Wyoming.

Harry Leyendecker, vice president of Eastern States Petroleum Company, was recently appointed to the National Petroleum Council. He is one of five new appointees to the Council, which advises the Interior Department on petroleum matters. Leyendecker is president of the Independent Refiners Association of America.

B. E. (Bert) Ashley has resigned as geologist with Phillips Petroleum Company, to join the U. S. Geological Survey's Alaskan and foreign geological branch. He recently left Denver, Colorado, for an assignment in Nyasaland, Southeast Africa.

C. E. Olmsted

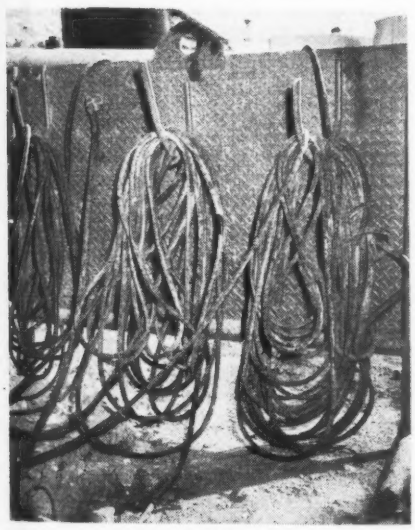
C. E. Olmsted, New York, was elected director of the American Standards Association. As vice president and director of The Texas Company and a member of the American Petroleum Institute, Olmsted has been in close touch with the extensive standardization of equipment, production practice, and test methods used by the oil industry. He has had experience in oil refining, transportation, marketing, and production. For 15 years before coming to New York he was with The Texas Company in Los Angeles.

Henry L. Phillips, president of Sinclair Oil and Gas Company has been elected a director of the National Bank of Tulsa. He has been with Sinclair since 1916, and is a member of the board of directors of Sinclair Oil Corporation and chairman of the board of Venezuelan Petroleum Company.

Kate C. Ornsen has joined Sun Oil Company's research and development department staff as technical librarian. She succeeds **Leila K. Henderson,** resigned. Miss Ornsen was formerly associated with the Monsanto Chemical Company in Dayton, Ohio.

Electrical Switchboard And Cable Rack Devised

An electrical panel board has been devised that also serves as a rack for the excess electrical cable. The unit is made up from short lengths of line pipe and a large piece of walk-way plate serves as the switchboard mounting and cable holder. Sucker rod or pumping rod material bent in "U" shapes and welded to the plate serve as hooks to hold the electrical cable. On the opposite side of the board is mounted the switch boxes with fuses controlling all electrical equipment on the rig. Prolonged life is given the cable by storing it as shown. Also accidents to personnel who might trip over the loose line is averted. A hoisting loop is welded to the top of the board allowing for quick portability of the unit. The panel was so constructed that it is impossible to plug wrong lines into the outlets. This was accomplished by using two, three, and four-pronged connections.



Eectrical Switchboard. Electrical panel board devised to serve as a rack for the excess electrical cable.

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James E. Pew

Samuel B. Eckert

James E. Pew, manager of Sun Oil Company's natural gas and natural gasoline division of the production department, has been elected to the company's board of directors. Pew, whose first jobs were with Sun Oil during summer vacations, joined the company in 1946 to head the newly-formed natural gas and gasoline division of the department.

A former student of MIT and Cornell University, Pew was director of the natural gas and natural gasoline division of the Petroleum Administration for War in Washington, D. C. For his outstanding service he received the Hanlon Award in 1945.

Samuel B. Eckert has been elected vice president of Sun. He was employed by Sun in 1908 as an assistant pipe fitter at the Marcus Hook refinery. He had been vice president in charge of marketing for 23 years before his election as executive vice president. Eckert was graduated from Cornell University in 1908 with the degree of mechanical engineer.

Eckert served as chairman of the supply and distribution committee, and later the distribution and marketing committee under the Petroleum Administration for War, and was also a member of the Petroleum Industry War Council during World War II.

Frank R. Markley was elected vice president in charge of marketing for Sun. He has been general sales manger for the company since 1946.

J. Dave Sterling has been elected president of Sunset Oil Company. As head of Eagle Oil and Refining Company, Inc., Sterling has long been an active and growing figure in the California gasoline industry and now, as president of two large oil companies, his activities expand over the entire Pacific Coast. Although the two companies will be operated separately, Sterling points out the obvious advantages to both organizations of cooperation in the management and coordination in the supply of material.

Other officers and directors of Eagle Oil Refining, Inc., who have also been appointed to similar positions in Sunset Oil, are **Morton A. Sterling,** vice president and manager of production; **Louis Lesser,** vice president; **Harvey Nelson,** secretary-treasurer, **Ralph Jones** and **A. S. Curtis,** directors. **John Vizzetti,** who was vice president and general manager of Sunset, continues in that capacity.

Reginald N. Blaize has been elected by the board of directors to the office of executive vice president of Eastern States Petroleum Company, Inc. A native of Mississippi, Blaize studied at Tulane University and Louisiana State University where he majored in chemical engineering. He received his BS degree from L.S.U. in 1934 and joined Lion Oil Refining Company after graduation.

Blaize joined Eastern States as inpection and process engineer in 1940. He formed his own company in the field of professional consultant service in 1945, and returned to Eastern States as the manager of refineries where he has served since 1948.

L. A. Cranson, executive vice president and director of Honolulu Oil Corporation of San Francisco, California was unanimously reelected president of Oil Producers Agency of California by the board of directors of the organization. Cranson has headed the statewide organization of the independent producers for the past two years, and is also a director of the Kettleman North Dome Association, and a member of many other oil industry groups.

Other officers, all reelected by the board for the ensuing year, are: **H. E. Woodworth,** Safe Oil, Bakersfield, first vice president; **R. A. Grant,** Fullerton Oil, Pasadena, second vice president; **W. H. Geis,** petroleum engineer, Los Angeles, third vice president; and **C. A. Johnson,** Holly Oil, Los Angeles, fourth vice president. **Rush M. Blodget** who has managed the agency since its organization in 1931, was reelected executive vice president. **W. A. Russell,** Seaboard Oil, Los Angeles, was reelected secretary-treasurer, and **Verne Harrell,** Bankline Oil, Los Angeles, was reelected assistant secretary-treasurer.

Directors whose terms have expired also were reelected by agency members. They are: **A. E. Bell, Jr., W. H. Geis, C. A. Johnson, L. Vander Leck, R. A. Grant, DeWitt Knox, D. W. Vedder, L. A. Cranson, R. E. Havenstrite, Cecil M. Rood, Rush M. Bloget, W. M. Comstock.**

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LAUGH WITH BARNEY

The plain, prim little old lady who stood beside a male customer at a department store counter was nervous and embarrassed; finally she said—"Please, miss, I'd like two packages of bathroom stationery."

" " "

"Does yo' take this woman for yo' lawfully wedded wife?" asked the colored parson, glancing at the diminutive, water eyed, bowlegged bridegroom, who stood beside 210 pounds of feminine assurance.

"Ah takes nothin'," responded the bridegroom. "Ah's bein' tooked."

" " "

Truck Driver: I oughta knock some sense into your head.

Other Truck Driver: Yeah? Neither you nor nobody else can do that, see?

" " "

"Dear Editor: What keeps those strapless evening gowns up"—in most cases it's a city ordinance.

" " "

"Oh, here's the place mother told me to stay away from. I thought we'd never find it."

" " "

Cannibal chief (calling his wife on the grapevine): Make the necessary preparations, honeychile; I'm bringing a man home for dinner.

A drunk lurching down the street bumped into a passerby. "Shay," he hiccoughed, "can you direct me to Alcoholish Anonymush?"

"Why, do you want to join?" inquired the bumpee.

"No, I wanna resign."

" " "

The rich retired contractor was sitting in his wheelchair beside an open window as a slick chick walked by, displaying a most attractive figure.

"Quick, Jenkins," called the old gentleman to his valet, "bring my teeth! I want to whistle."

" " "

"Mamma, how do you get the cubic contents of a barrel?"

"I don't know. Ask your father."

" " "

The minister was reading several announcements from the pulpit. "The Ladies of Charity will meet at nine o'clock Tuesday evening. The ladies of the sewing circle are to meet in Mrs. Brown's house Wednesday evening, and the newly organized Society of Little Mothers will have its first meeting on Thursday night. If there are any ladies in the congregation desirous of becoming Little Mothers will they please speak to the minister after services."

The welder, stopped by a policeman for speeding, angrily called the cop an ass . . . When he'd paid his fine the judge reproved him for what he'd said to the cop.

"Judge, you mean I shouldn't call a policeman an ass?"

"Certainly not," said the judge, "you must have respect for authority and not insult the police?"

"Well, Judge," the welder went on, "you wouldn't care if I called an ass a policeman, would you?' '

The judge pondered this a moment then his eyes twinkled.

"Why, no, I suppose not."

The welder turned to the officer who had arrested him: "Goodbye, policeman."

" " "

A lady on a Pullman was annoyed by the snoring of a man in the upper berth. Exasperated, she knocked on the ceiling of her sleeper. Finally the man stopped snoring and called, "I saw you come in and I'm not coming down."

" " "

A speech is like a wheel; the longer the spoke, the greater the tire.

" " "

"It's difficult to explain what a course in Logic will do for a person's thinking, but let me illustrate," the professor told a student.

"Suppose two men came out of a chimney,—one is clean, one dirty. Which takes a bath?"

"The dirty one naturally," answered the student.

"Remember," chided the professor, "that the clean man sees the dirty one and vice versa."

"Now I get it," said the student. "The clean one, seeing the dirty companion, concludes he is dirty too,—so he takes a bath. Am I right?"

"Wrong," said the professor nonchalantly. "Logic teaches this: how could two men come out of a chimney, one clean and one dirty?"

" " "

The Engineer

With clouded wits the engineer sits
  and pushes pens and pencils . . .
While day by day, years slide away
  among his inks and stencils . . .
He works and works and never shirks
  ((He couldn't do without it . . .)
And if he stops . . . Asleep he drops
  and then he dreams about it.
With head that sinks and frame that
  shrinks he does his toilsome
  duties . . .
Without a glance from gay romance
  and blind to all her beauties
And when at last his life is past . . .
  there comes no chance to show it
For engineers are dead for years
  before they ever know it . . .

OIL AND GAS TRADE NEWS

GE Communications System

General Electric has announced that it will build equipment for the world's longest micro-wave radio communications system. The system has been purchased by the Transcontinental Gas Pipe Line Corporation for the operation and maintenance of its 1840-mile line now under construction from Mercedes, Texas, to New York City.

W. R. G. Baker, General Electric vice president at Electronics Park in Syracuse, New York, where the equipment will be built, said the radio project will cost almost a million dollars and is the biggest of its kind.

"The communications system will cover the entire 1840-mile pipe line through which Transcontinental will deliver natural gas from fields in Texas and Louisiana to distributors and homes in Pennsylvania, New Jersey, and New York," he said.

"Pipe line officials in district offices, main terminal, and intermediate compressor stations will be able to talk over the entire route as they exchange operational and sales details by micro-wave communications."

First delivery of micro-wave equipment is expected early in October. Plans call for operation of the communications system from Houston to New York by November 15. The entire installation will be complete by March, 1951.

Hercules Moves Houston Office

Hercules Motors Corporation, Canton, Ohio has moved its Houston, Texas branch from 1319 Conti Street, to 6818 Navigation Boulevard. The expanded facilities at the new address will permit increased services for engine users in the Houston area, the company announced. A complete stock of Hercules service repair parts will be maintained at all times, as well as an enlarged stock of Hercules engines and power units.

A new, fully equipped, machine shop has been installed to provide quick and economical repairs and overhaul on diesel, gasoline, and natural gas engines, and power units.

Otis Officials Meet. District superintendents and other key personnel of Otis Pressure Control, Inc., gathered at the service and equipment company's home office in Dallas for three days recently for an annual superintendents' meeting.

L to R are: C. E. Ivey, chief inspector; H. C. Laird, vice president and production manager; T. G. Garwood, Gulf Coast district sales manager; B. C. Brown, Oklahoma City district superintendent; D. E. Daffin, Houston division superintendent; R. L. Green, Odessa district superintendent; Miss Mary E. Warren, secretary of the firm; W. E. Rich, treasurer; H. C. Otis, president; George Hart, export representative; E. A. Kelley, New Iberia division superintendent; I. A. Miller, general superintendent; L. M. Wilhoit, general sales manager and assistant general superintendent; Bob L. Crain, Longview district supt.; J. D. Toole, Corpus Christi division supt.; H. C. Otis, Jr., director, and W. L. Long, general tubing supt.

More Industries Tackle Noise Abatement Problem

Greater output demands and consequent use of more machinery is increasing the national industrial noise problem for management, labor, and insurance companies, it has been reported by Burgess-Manning Company.

A report from the sound laboratories of Burgess-Manning indicates that more industries are recognizing the menace of uncontrolled noise as a health and efficiency hazard and are having their individual problems studied in order to take corrective action. The petroleum industry and the utilities are leading in the study and alleviation of industrial noises, according to the Burgess-Manning findings.

Ideco Opens Store at Snyder

T. D. Collins, vice president, Ideco Supply Stores division, has announced the opening of a new Ideco oilfield supply store at Snyder, Texas. C. W. Nichols has been appointed store manager. This new installation will be operated under the direction of W. S. Nelson, district manager.

Here's a little Booklet

with a lot of information on how to CUT MAINTENANCE CLEANING COSTS

Send for your **FREE** *copy today!*

This 32-page booklet is packed with job-tested data on "in-place" cleaning of stabilizing, fractionating, absorption towers; on "in-place" cleaning and descaling of heat exchangers; on cleaning and de-rusting barrels and drums for re-use; on cleaning in connection with salvaging; on the cleaning of tank car interiors and many other regularly scheduled maintenance cleaning operations.

The scientific Oakite cleaning methods described in this booklet have proved successful money-and time-savers for many of the nation's leading petroleum producers, refiners and marketers. Get your FREE copy today! No obligation, of course. Oakite Products Inc., 37 Thames Street, New York 6, N. Y.

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PETROLEUM SERVICE DIVISION

Snow Aids Installation Of Gas Storage Tanks

The Austin Company, resident engineers and builders at The Dow Chemical Company, Midland, Michigan, recently installed four 40-ton 8-ft diameter by 70 ft long, 30,000 gal capacity gas storage tanks. Three flat-cars were required to transport each tank from Chester, Pennsylvania, to the Dow property.

The problem was to move the cumbersome vessels from the Dow railway siding to the point of installation about one-fourth mile distant. Realizing that the coefficient of sliding friction would be reduced from an estimated "f" of 0.2 for dry ground to "f" 0.02 for snow, it was decided to wait for the early snow that was predicted.

After the snow had fallen, two 25-ton motor-jib-cranes lowered the tank to the ground. Then a D-8 caterpillar tractor was harnessed to the front of a tank; at the rear a Lorain motor crane pushed. With this power, the tanks were skidded along the snow for the entire distance with ease.

Farrel-Birmingham Holds Stockholders' Meeting

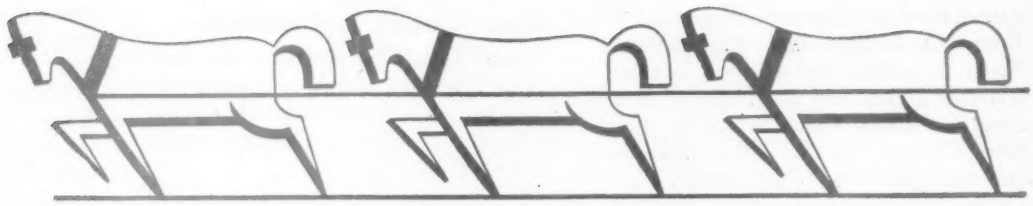
At the annual meeting of the stockholders of Farrel-Birmingham Company, Inc., held at Ansonia, Connecticut, recently, all of the members of the board of directors were reelected. They are: Fernley H. Banbury, Alton Austin Cheney, Lester D. Chirgwin, Julius G. Day, Frederick M. Drew, Jr., Franklin Farrel, Jr., Franklin Farrel 3d, William A. Gordon, Carl Hitchcock, Franklin R. Hoadley, Robert M. Honegger, Armin K. Kessler, Austin Kuhns, Joseph LeMay, Carl F. Schnuck.

At the directors' meeting which followed, Franklin Farrel 3d was elected executive vice president; Joseph LeMay secretary and assistant treasurer; and Mrs. Wiliford Whiteside, assistant secretary. All other officers were reelected, as follows: Alton Austin Cheney, chairman of the board; Franklin R. Hoadley, president; Austin Kuhns, vice president and chairman of the finance committee; Lester D. Chirgwin, Carl Hitchcock, and Armin G. Kessler, vice presidents; and Frederick M. Drew, Jr., treasurer.

Regan Made Sales Agent

Regan Forge and Engineering Company, San Pedro, California, has been named sales agent in California for Camco gas lift valves, Paul Mills, chairman of the board of Camco, Inc., has announced. Regan will handle service and installations as well as sales, Mills said. The first installations of Camco valves were made in the Paloma field, near Taft, California.

HARNESS WASTE HORSEPOWER WITH

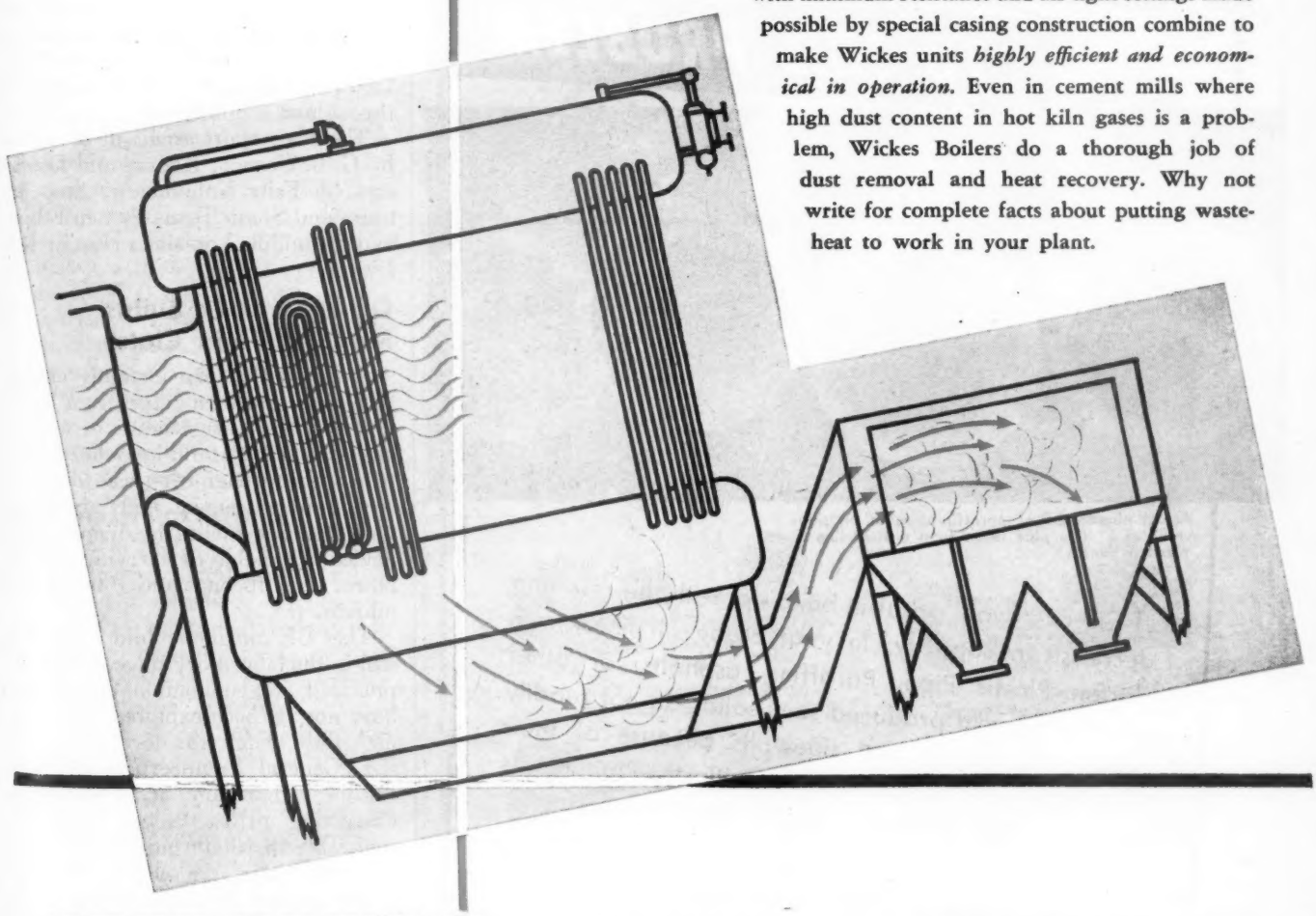


WICKES WASTE-HEAT BOILERS

CONVERT WASTE-HEAT into PROFITABLE POWER

Waste heat, once discharged from manufacturing equipment as a loss, has been made to realize a high economic return through the installation of Wickes Waste-Heat Boilers. In actual cases, the reduction in the costs of manufactured products has *paid for the waste-heat installation* within 2-3 years time, and in some industries, heat recovery is sufficient to produce all steam and power required.

Wickes Boilers are correctly designed and built to effect maximum heat recovery from all types of waste gases. High gas velocity, long gas travel with minimum resistance and air-tight settings made possible by special casing construction combine to make Wickes units *highly efficient and economical in operation.* Even in cement mills where high dust content in hot kiln gases is a problem, Wickes Boilers do a thorough job of dust removal and heat recovery. Why not write for complete facts about putting waste-heat to work in your plant.



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RECOGNIZED QUALITY SINCE 1854

Marmon Herrington Buys Ford Motor Coach Rights

The manufacturing and sales rights for Ford Motor Coaches have been purchased by Marmon-Herrington Company, Inc., Indianapolis, Indiana. These motor coaches will now be manufactured and sold as "Marmon-Herrington Motor Coaches". This new line of motor coaches will be built in the range of 27 to 35 passenger.

Charles Guernsey, vice president in charge of the transit equipment division of Marmon-Herrington states that this new enterprise will in no way affect the production and sale of Marmon-Herrington Trolley Coaches, which will continue to be sold by the Marmon-Herrington Company direct to users.

Metal Goods Is Distributor

Metal Goods Corporation has been appointed the exclusive distributor for Childers aluminum weather-proof jacketing in the mid-west and southwest areas.

The finished jacketing is packaged in 100 ft rolls, ready for use over moulded pipe insulation. It can be attached by aluminum bands, special plastic tape, or sheet metal screws.

CARLON PLASTIC PIPE

IS THE ANSWER

TO THIS PROBLEM

Actual photograph of paraffin deposits on sidewalls of 3" line pipe taken from a flow line in Western Kansas.

YOU can avoid paraffin build-up, with the resulting decrease in capacity, in your crude oil lines, with Carlon Plastic Pipe. Paraffins, asphalts, or other alkaline or acid produced semi-solids do not readily adhere to the internal sidewalls because of their smooth internal surface. Carlon Plastic Pipe resists corrosion, and electrolytic action does not occur.

Let us show you how to solve your paraffin and corrosion problems with Carlon Plastic Pipe.

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CARTER PRODUCTS CORPORATION, CLEVELAND, OHIO, MFRS.

Lefferty Made Sales Manager

H. F. (Skip) Lefferty has been named Pacific Coast sales manager of the Babcock and Wilcox Tube Company. Lefferty succeeds H. P. Curtis who has resigned to enter other activities.

Lefferty has been with Babcock and Wilcox for 33 years. From 1917 to 1928 he was associated with the Babcock and Wilcox Company, first at Beaver Falls, Pennsylvania, and later at the company's Bayonne, New Jersey and Barberton, Ohio plants. He transferred his activities to the sales department of the Tube Company in 1928. Since then he has been manager of the Cleveland sales office, district sales manager at the Beaver Falls office, and recently, district sales manager at the Chicago office.

Tube-Kote Sets Up Sales Territories

G. O. Carroll, sales manager of Tube-Kote, Inc., Houston, Texas, applicators of thermosetting, baked-on, plastic coatings for the oil and chemical industries, has announced the establishment of sales and service territories to better serve their customers throughout the industry.

The Shreveport area will be served by G. L. Garner; Kansas and Louisiana by Fritz Kohlhausen; San Antonio and South Texas by Len Edgar, and the middle Louisiana area by Bob Dwyer.

GE Laboratory Builds Magnetic-Fluid Clutch

A liquid that can instantly change to a solid and then return to a liquid again is the basic feature of a magnetic-fluid clutch built by General Electric Company engineers, according to a recent announcement. Only six inches long and six inches in diameter the device is capable of carrying enough power to lift one ton 1000 ft per minute.

The GE magnetic-fluid clutch is still in the laboratory stage, it was emphasized, and commercial possibilities have not yet been explored. The magnetic-fluid clutch was developed in the G-E General Engineering and Consulting Laboratory at Schenectady. Consisting of two metal cylinders, each able to rotate independently on the same axis, the clutch transmits rotary power from its source to its load. The cylinders are separated by a magnetic mixture of oil and finely-divided iron powder.

When the unit is energized, the fluid instantly solidifies, making a rigid connection between the two cylinders, so that as one cylinder revolves, its motion is transmitted to the other.

Larkin Opens Warehouse

The Larkin Packer Company, St. Louis, Missouri, has opened a new warehouse in Kilgore, Texas. A complete stock will be carried and will materially increase the service Larkin can give to its East Texas customers.

Name Bigelow-Liptak Agents

Bigelow-Liptak Corporation, Detroit, Michigan, has established an office in Tulsa, Oklahoma, under the supervision of Charles F. Koos. Koos will cover Oklahoma, New Mexico, and a portion of Texas and Arkansas in the sale of Bigelow-Liptak industrial enclosures and industrial insulation. The company has also established an office in Portland, Oregon, under the supervision of J. A. Schruefer, who will cover southern Washington and Oregon.

Armin O. Schleiffarth has been named St. Louis, Missouri, representative for the company.

Order Microwave Equipment

Texas Gas Transmission Corporation has announced that Motorola Inc. has been awarded the contract for a pilot installation of microwave communications equipment. If this pilot installation proves satisfactory, the company may eventually adopt microwave communication for its entire pipe line system.

Consisting of two terminal stations and one repeater station, the Motorola microwave system will utilize a frequency with a wave length only 1¾ in. long. Using parabolic and flat reflectors and three 150-ft towers, the equipment will transmit narrow beams of these high-frequency radio waves between the stations. In this way, the installation can perform the function of telephone lines using 1500 poles and 250 miles of wire.

Transfer Dallas Branch

The Kaylo division, Owens-Illinois Glass Company, manufacturer of heat insulating and structural calcium-silicate material, has transferred its Dallas branch to Houston, Texas, and appointed J. K. Dixon as sales engineer for the Houston territory. Dixon's office will be at 2201 Neils-Esperson Building, Houston 2, Texas, and his territory will include the Gulf Coast east to Florida, the entire state of Louisiana, and Texas as far north as Waco and San Angelo. Another new branch, Oklahoma City, will be added soon, the division announced.

T. F. Sears, former Dallas branch sales engineer, has been promoted to the general office in Toledo, Ohio as supervisor of roof tile sales for the entire Kaylo Division. Dixon, new Houston Kaylo sales engineer, joined Owens-Illinois in February.

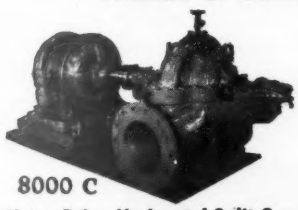
DEAN BROTHERS PUMPS INC. INDEANAPOLIS, INDEANA. PUMPING MACHINERY

CENTRIFUGAL PUMPS

RECIPROCATING PUMPS

PUMPS

BUILDERS OF OUTSTANDING PUMPS SINCE 1869



8000 C

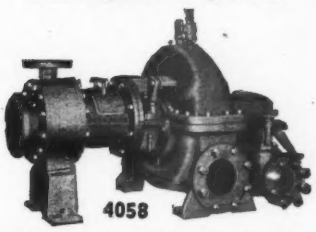
Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

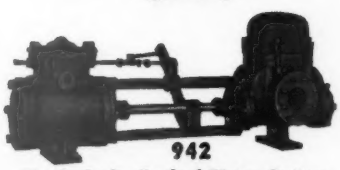
4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump



942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

3833

Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W. TENTH ST.

Chiksan Establishes Eastern Warehouse Stock

Chiksan Company has established a warehouse stock in the Federal Storage Building, 155 Washington Street, Newark 2, New Jersey, where eastern headquarters for Chiksan and Chiksan Export are being transferred. Headquarters were formerly at 50 Church Street, New York 7, New York.

"The establishment of a warehouse stock of Chiksan and Weco products and Okadee loading rack valves in the East will enable Chiksan to handle orders and shipments promptly and will substantially reduce time in transit on all deliveries in this area," G. R. Winder, vice president and general manager, stated.

The entire New York office staff, including R. T. Jones and L. J. Smith, sales engineers, and E. T. Landgraff, manager, will move to the new quarters in Newark.

Ship Cementing Unit Overseas

On of the largest cementing units for an overseas oil field was shipped recently by International Cementers, Inc., Long Beach, California according to Art Thompson, Wilmington superintendent of the American President Lines. With a gross weight of 52,035 lb and crated ready-to-drive-away, this pumping unit and its auxiliary equipment is mounted on a heavy duty diesel truck. Destined for Sarawak Oilfields Ltd., Seria, Sarawak via Kabuan, the unit was loaded on the S.S. President Johnson and commenced its long journey February 10, it was reported.

Capable of high volumetric capacity with sustained pressures up to 10,000 psi, the pumping unit has three 4¾-in. plungers on one side and three 3½-in. plungers on the other side. It is manifolded so that both sides provide high volume at low pressure; the 4¾-in. side for medium pressures—the 3½ in. side for maximum volume at high pressures.

Somner Names Agents

The W. L. Somner Company, Inc., has been named exclusive agents for the Eastman Oil Well Survey Company in Brookhaven and Tinsley, Mississippi, and Shreveport, Louisiana. W. L. Somner is president of the company, and H. G. Lawrence is general sales manager of the Louisiana concern. Their representation of the Eastman company in that territory will include the rentals of Eastman Single Shot and Drift Indicator instruments and casing rollers.

Iverson Enters Gulf Coast With Houston Headquarters

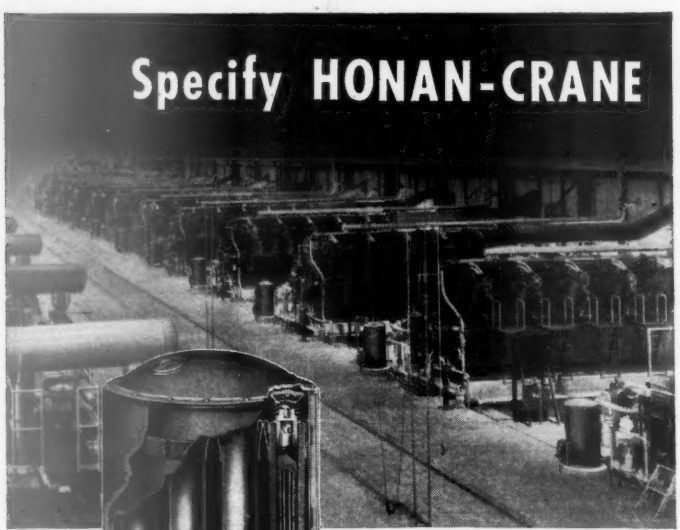
Iverson Supply Company has expanded its sales and service operations to cover the Gulf Coastal area, and a recent open house at the modernistic new division office and warehouse at 340 South 66th Street, Houston, announced the move to a large group of key-man operators. A complete stock of drilling, production, and refinery equipment is ready for delivery through this new Houston location under the direction of R. B. "Bob" Yanaway, division manager in the Gulf Coast.

Kennedy Valve Buys Semler Company

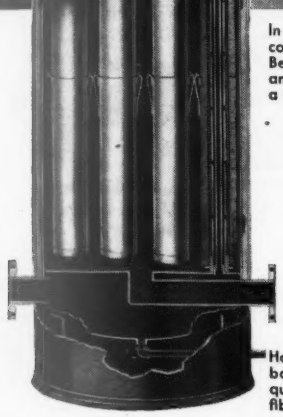
Purchase of the Semler Company, Jeannette, Pennsylvania, manufacturer of cast-iron pipe fittings has been announced by Charles F. Kennedy, president of The Kennedy Valve Manufacturing Company, Elmira, N. Y.

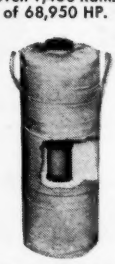
The Semler Company, with about 220 employees, has been engaged in the manufacture of cast-iron fittings since 1915. New officers of the company are: Charles F. Kennedy, president; J. Lawrence Kennedy and Howard P. Semler, vice presidents, and Thomas S. Turkington, controller.

Specify HONAN-CRANE Oil Purification for DIESELS



In this plant Honan-Crane Purifiers are direct connected to twenty-four 1,000 HP Cooper-Bessemers; nineteen 1,000 HP Worthingtons and eleven 1,450 Rathburn Jones engines . . . a total of 68,950 HP.





Honan-Crane Purifiers are available with both single and multiple cartridge-type, quick-change refills . . . using either cellulose fiber, or fullers earth purifying media.

Proven Design Increases Safe-Use Life of Oil... Cuts Maintenance Costs

Honan-Crane Oil Purifiers are the choice of leading Diesel operators and engineers for purification of lubrication oils in Diesel Engines.

Honan-Crane's purifiers remove abrasives, acids, sludges and all other types of damaging contamination . . . give maximum protection against bearing failure . . . extend safe-use life of oil, thereby reducing the need for frequent oil changes. Design characteristics of Honan-Crane Purifiers have been tested thoroughly for many years under all kinds of operating conditions.

On-the-job performance has proved that the *best* saves you *most* in the long run. Give your diesels the finest protection you can buy . . . specify HONAN-CRANE.

For complete information (or, a Honan-Crane resident engineer will call at your request) . . . write to Honan-Crane, 573 Wabash Avenue, Lebanon, Ind.

HONAN-CRANE CORP., Lebanon, Indiana
Subsidiary of HOUDAILLE-HERSHEY CORP.

IT'S LEBUS FOR ONE BLOCK

THAT SERVES ALL PURPOSES THAT IS ASSEMBLED AND OPENED BY HAND

"ALL-PURPOSE" SNATCH BLOCKS

SUPER SAFETY TYPE

The "All-Purpose" and Gin Pole Block Adaptable to Trucking, Drilling Rig or Production Work

This revolutionary LeBus Block is built for Speed and Safety. As shown at right, the block opens for line with no need for tools. Block is left hanging—hinge pin is turned 90° and pushed through slot—the side plate turned to one side and the line inserted.

- Drop Forged, Alloy-Steel Heat-Treated Hooks, Swivel Yokes, Body Side Plates, Flame-Hardened Line Groove Sheaves, One Piece Ground Sheave Pins, One Piece Swivel Yoke Hinge Pins.
- Bronze Hub Caps on Sheaves to Prevent Sparking and Side Plate Friction.
- Alemite Oiling, Brass and Felt Oil and Dust Seals in, Sheaves.
- Precision Construction • No Accidental Opening by Jarring or Vibration • No Threaded Nuts or Bolts to Burr • No Tools Required to Assemble and Disassemble • No Sparking Danger

As Tail-Board Block

May be changed to Tailboard Type Block by removing hook and yoke assembly—or may be purchased as shown. Available immediately.

Patents Pending

All Popular Sizes for manila and wire line—working load capacities from 6 tons through 25 tons.

Sold Only Through Supply Store or Dealer

LEBUS ROTARY TOOL WORKS, INC.

P. O. BOX 2352 — PHONE 1232 — LONGVIEW, TEXAS

Write for illustrated catalog sheet 1000 NOW.

Purchase Vulcan Corporation

The Vulcan Steel Tank Corporation in Tulsa, Oklahoma, has recently been purchased by Charles A. McNamar, Lawrence N. McKelvey, and A. W. (Tony) Crowley.

McNamar, the new president, attended Notre Dame University and afterwards joined his father in the manufacture of the McNamar drilling boiler. In 1932 he moved to Tulsa, where, together with his father, they founded the present McNamar Boiler and Tank Company.

McKelvey, executive vice president and general manager of Vulcan, joined the company in 1927. Crowley, a graduate of Notre Dame, was formerly with the Bethlehem Supply Company. He began working with Vulcan in 1938.

Visco Changes Personnel

Carl L. Wallace has been appointed Gulf Coast division manager for Visco Products Company, with headquarters in Houston, Texas. He was formerly district representative covering northern Louisiana and southern Arkansas. Vernon G. McBride is replacing Wallace, and he will make his headquarters in Ruston, Louisiana.

Aubrey L. Adams has been appointed district representative covering the Houston area, replacing David E. Murphy, who has been transferred to district representative in California with headquarters in Long Beach. Paul H. Mallette has been appointed district representative with headquarters in El Campo, Texas, and will cover that area.

Sharpe Made Branch Manager

Robert F. Sharpe has been named branch manager for The White Motor Company in Dallas, Texas. Sharpe has been regional wholesale manager for the company in Kansas City, Missouri, for the past year, and previously was with the company in Cleveland. Before joining the White sales organization, he was affiliated with the Firestone Tire and Rubber Company.

Succeeding Sharpe at Kansas City will be B. E. Simons, who has been business manager for White in that city.

Kobe Opens West Texas Shop

Kobe, Inc., has announced the opening of a hydraulic pump repair shop in Odessa, Texas. For both free type and conventional pump operations in West Texas the new shop will provide a faster repair service. The shop has complete facilities for tearing-down, re-assembling, and testing pumps. The Odessa shop was formally opened with a shopwarming.

Awarded Safety Plaques. John G. Staudt, executive vice president and general manager of Dowell Incorporated, awarded safety plaques to managers of four Dowell districts at a Spring conference in Tulsa, Oklahoma, winners in an annual safety contest. They are: Staudt; W. S. Day, Mt. Pleasant, Michigan; Jack Sutherlin, Wichita Falls, Texas; Jim A. Cummin, Wichita, Kansas; and Charles L. Power, Jr., New Orleans, Louisiana.

Telematic Appoints Agent

Telematic Corporation of Chicago, Illinois, has appointed Harry H. Tinch, president of Pipe Line Engineering and Equipment Company, Houston, Texas, and his organization, as sales representative in Texas.

The Telematic Company manufactures remote reading liquid level gaging equipment for oil storage, and has numerous tank level gage installations in operation.

Instrument Course To Open

July 10 and 14 mark the beginning and the end of the third quarterly instrumentation course for 1950 at the Hatboro, Pennsylvania plant of Fischer and Porter Company. Manufacture, calibration, installation, operation, and maintenance of flow (variable-area and orifice), liquid level, etc., will be covered.

Additional information can be obtained by writing the company.

Cross-Country Sales Tour. W. H. Whitney, president and general manager of Whitney Chain and Manufacturing Company, Hartford, Connecticut, accompanied by J. W. Anderson, sales manager, just completed an extensive field trip via air, calling on Whitney field offices and key distributors across the country. Above are, L to R: C. B. Lane, Dallas, district manager; J. W. Wiley of Beech Aircraft Corporation; J. W. Anderson, Whitney Sales Manager; Whitney; L. J. Snow, pilot; E. P. Coty, Hanson Whitney machine company.

TRADE PERSONALS

J. P. Bristow has resigned as vice president of Tennessee Gas and Transmission Company, and has established the J. P. Bristow and Company, which will be engaged in consulting work in the natural gas and petroleum industries. He has been retained by Tennessee Gas in a consulting capacity.

The new firm will have offices in City National Bank Building, Houston, Texas. It will specialize in reports, appraisals, and designs, as well as act as engineer and consultant in the construction of pipe lines, plants, and distribution systems.

Paul Stewart has joined Climax Engine and Pump Manufacturing Company as assistant general sales manager, Southern division. For the past five years Stewart has been associated with Carson Machine and Supply Company, formerly as manager of the Kansas district, and for the past two years as manager of the engine division.

Stewart will make his headquarters at Dallas, Texas.

Harry C. Trimble has established headquarters at 1106 West Indiana Street, Midland, Texas to direct sales and service of the A-1 Bit & Tool Company products.

A former driller in Kansas, Oklahoma, and Mississippi, Trimble joined A-1 Bit and Tool as a service tool operator in 1946.

Robert D. Burkhart, Key Company, East St. Louis, Illinois, was transferred recently to the staff of the company's Eastern office at 420 Lexington Avenue, New York City. Burkhart has been with Key Company for 16 years.

Ralph E. Becker, formerly national advertising manager for the Charles Bruning Company has joined the staff of Homer J. Buckley and Associates, Inc., Chicago agency, as an account executive. Prior to his affiliation with Bruning, Becker served several national accounts as consultant-designer for printed material and direct advertising.

Take Training Course. Seven men from the sales engineering staff of Core Laboratories, Inc., Dallas, Texas, headed by W. E. Stiles, manager of sales, recently took a 10-day training course in the use of Black Magic oil base drilling fluid, White Magic oil emulsion mud, and other mud products manufactured by Oil Base, Inc., Compton, California.

The men are, back row: Dick Duke, co-pilot; Bob Cole, pilot; Bill Stiles, Core Lab sales manager; Roy Hightower. Front row: Dick Willshusen, Vincent Thomas, Bill Brown, and Bill Hilliard.

G. W. Hundinger

George W. Hundinger was elected secretary of the New Bedford Cordage Company, New Bedford, Massachusetts.

Hundinger has been with the company over 30 years. Until his appointment, he has been director of oil field sales and prior to that, Chicago branch manager.

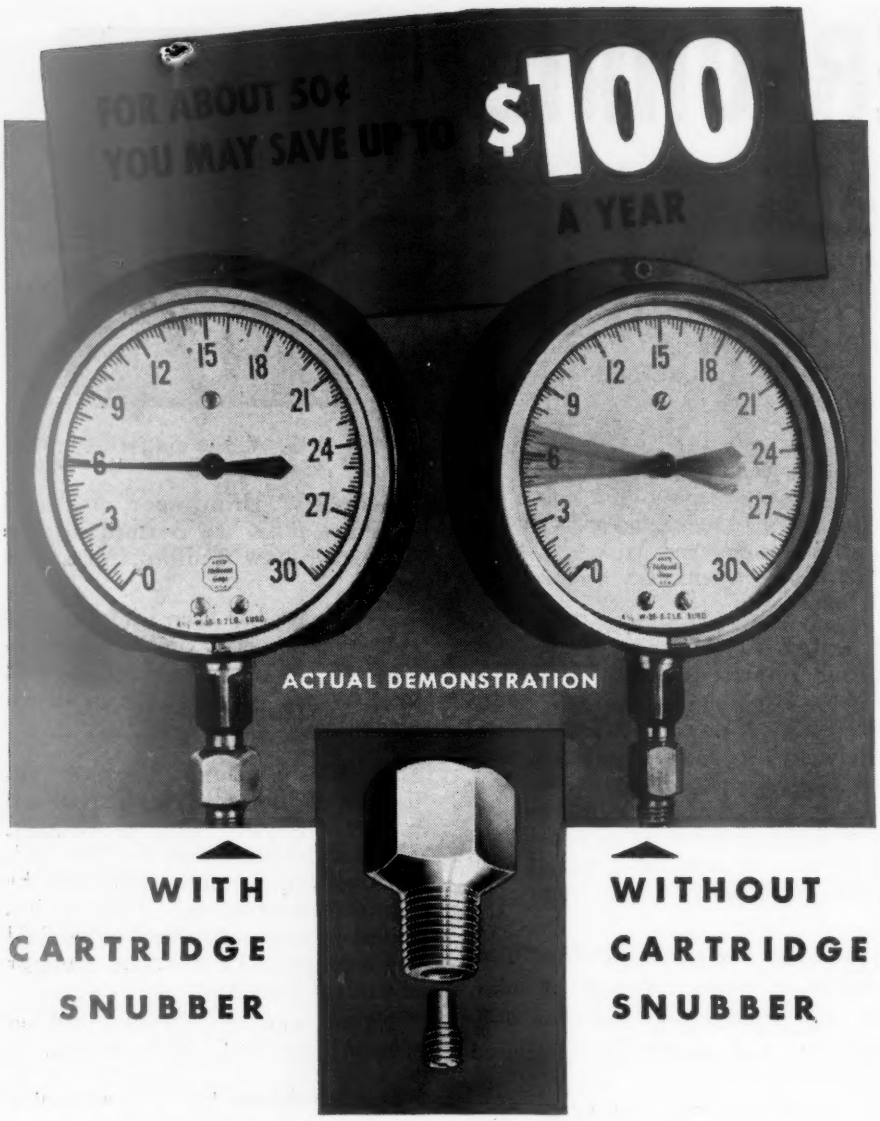
R. Wesley Burns has been appointed division manager of National Supply Company, Ltd. at Calgary, Alberta, Canada. Burns has been with National Supply since 1921 when he joined them at the age of 15. He has served in store sales, field sales, field engineering, and was a store manager at Craig, Colorado.

He was appointed assistant division sales manager at Calgary last year.

Lee Snodgrass has been appointed Pacific coast supervisor of the gasoline and oil meter division of Rockwell Manufacturing Company. Snodgrass began in the valve division of Rockwell Manufacturing Company in 1941 and for the past few years has been specializing in oil and gasoline meter sales.

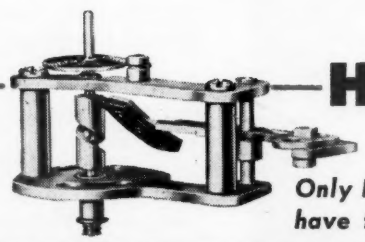
O. O. Lewis has been elected vice president in charge of sales, and **F. J. Heaslip,** vice president in charge of purchases and traffic for Fairbanks, Morse and Company. Lewis joined the organization in 1908 as a clerk, and became sales manager in the Chicago, Illinois headquarters in 1948.

Walter A. Huber has been appointed general manager of the wire rope division, John A. Roebling's Sons Company. The appointment is part of a plan to decentralize the company's various divisions. The objective of the new program is to specialize each product division for more production efficiency and better service to customers. Mr. Huber will coordinate administrative and production work with merchandising schedules and customer requirements.



● Why wreck gages needlessly? When pressure pulsations are so rapid that the gage pointer vibrates excessively, a HELICOID Cartridge Snubber is needed. This is the most simple and effective of all pressure pulsation dampeners. It is threaded into the gage socket for only 54¢. It may save you up to $100.00 a year in gage replacement expense!

For severe pulsation services, order your Helicoid gages with snubber cartridges in the socket. Or, order complete snubbers separately. Specify for water, air or oil; ¼" or ½"; bronze or stainless steel.



HELICOID

Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

TRADE MARK

▸ **Otho V. Tally** has been named manager of Allis-Chalmers Midwest region succeeding **Benjamin F. Bilsland,** who is retiring July 1 after more than 30 years of service. Tally joined the company in 1930. He was formerly manager of the St. Louis district. He is succeeded there by **Baldwin G. Witty,** formerly a sales representative in the company's Chicago office. Witty has been with the company since 1933.

▸ **T. A. "Tom" Ramey,** formerly sales manager for the Unit Rig and Equipment Company, has joined International Derrick and Equipment Company as general manager of domestic sales.

Ramey has had 16 years experience in oilfield equipment sales engineering. A petroleum engineering graduate of the University of Southern California, he joined the National Supply Company in California in 1934, and in 1947, he joined Unit Rig and Equipment.

▸ **John A. Menster** has been appointed assistant manager of sales for the welded tube division of The Babcock & Wilcox Tube Company. Menster is a graduate of Ohio University, Athens, Ohio.

He has been with Babcock and Wilcox Tube since 1943, beginning in the general sales office and serving as manager of the office from 1944 until 1947.

▸ **LeRoy E. Burner,** formerly special sales representative for the National Supply Company, has joined the International Derrick and Equipment Company's supply store staff as district manager for the state of Oklahoma. He joined National Supply in 1935, successively holding positions of field salesman, store manager, district sales representative and special sales representative.

T. D. "Hi" Collins has been appointed to the board of directors of International Derrick. Collins was for many years associated with Continental Supply Company, commencing his service with that company at Ranger, Texas.

As vice president of IDECO, Collins is in charge of IDECO supply stores division.

▸ **Russell W. McIntosh** has been appointed West Coast representative for Pittsburgh protective coatings, Pittsburgh Coke and Chemical Company.

An active member of NACE, AWWA, and the California Sewage Works Association, McIntosh handled sales for the Koppers Company, Inc., in Northern California, Washington, Oregon, and British Columbia, Canada, prior to his affiliation with Pittsburgh Coke and Chemical Company.

Wrap it better

- wrap it faster!

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FIBERGLAS

COROMAT* pipe wrap

Cuts Application Costs . . . Coromat, now with tear strength greatly increased, allows crews to run wrapping machines *faster,* with zero incidence of breaks! More miles are covered every day and application can be speeded greatly.

Stops Corrosion . . . a combination of coatings and Fiberglas Coromat resists moisture, acids and soil stress. The high porosity of Fiberglas Coromat permits uniform and complete penetration, eliminates a common cause of holidays.

Low Cost . . . even though offering greater protective qualities, Coromat costs less than 1½¢ per square foot.

1. **Provides better penetration.**
2. **Fibers of glass cannot rot, decay or absorb moisture.**
3. **Easy to handle and apply.**
4. **Extra impact strength resists rock breakage 2 to 3 times better.**
5. **Higher enamel pick-up—greater surface area takes more enamel.**
6. **Retains full strength under hot application.**
7. **Fiberglas Coromat resists all soil acids encountered.**
8. **Dielectric strength inherent in enamels is not decreased by Fiberglas mat.**

FREE booklet *"Corrosion Protection For Underground Pipe" and a free sample of this stronger Coromat are available to you. Write today to Owens-Corning Fiberglas Corporation, Dept. 55-E, Toledo 1, Ohio. Branches in principal cities.*

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**Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers Coromat is the trade-mark of Owens-Corning Fiberglas Corporation.*

Harry Sanford Brown, president and chairman of the board of the Foster Wheeler Corporation, died recently on ship-board en route from New York to Rio de Janeiro.

Brown was elected president of Foster Wheeler in 1935, and chairman of the board in 1946. He joined the Wheeler Condenser and Engineering Company as vice president in 1910, and in 1927, when the two companies merged, Brown became vice president and director of Foster Wheeler.

Cecil H. Gay, works manager of the Barberton plant of The Babcock and Wilcox Company, has been elected as vice president of the company.

Gay, who joined the company after graduation from the University of Nevada in 1928, has been connected with the Barberton operations since 1932. As a special assignments engineer for the company he had an important part in designing and building the world's largest penstocks for Hoover (Boulder) Dam, and for Gauley Bridge in West Virginia.

Harry G. Smith has been appointed vice president and director of sales for The Ohio Injector Company, Wadsworth, Ohio. Smith comes to OIC from the A. O. Smith Corporation, Los Angeles, where he was manager in charge of administration, sales, manufacturing, and engineering of the meter division.

He is affiliated with the American Society of Mechanical Engineers, American Petroleum Institute, and Association of Weights and Measurement Officials. As a member of the joint ASME-API fluid measurement committee, he assisted in the preparation of the "Code on Positive Displacement Meter Measurement."

V. L. Merle, former vice president, is the newly-elected president of Wright Chemical Corporation, Chicago, Illinois, water-conditioning firm. Other officers elected at the annual director's meeting are: **H. C. Daggett** and **H. J. Meacher,** vice presidents, and Merle, treasurer.

Daggett will supervise and coordinate the activities of Wright's six sales districts in the U. S., and Meacher will be in charge of the company's advertising and public relations.

W. S. Sease will serve as Globe Oil Tools representative in Dallas, Texas, and will handle the complete line of Clobe rock bits, junk catcher, hole opener, and side hole cutter. Sease was graduated from Yale University in 1928, where he received a degree in engineering.

Edward Morris Smith, industrialist and philanthropist, passed away recently at his home in Arcadia, California. He had been critically ill for nearly a year. Smith was well known throughout the world petroleum, automotive, and allied industries, in which he had been actively engaged for more than half a century.

Smith organized and directed the Emsco Steel Products Company and the Emsco Tool Company of Los Angeles, California during the early twenties. These companies later were merged as the Emsco Derrick and Equipment Company. He also organized the E. M. Smith Company, and later the Grizzly Manufacturing Company of Los Angeles.

At the time of his death, he was president of the Globe Oil Tools Company of Los Nietos, California.

James A. Cowan has been transferred to Pittsburgh, Pennsylvania, as direct factory representative for Macwhyte Company, wire rope manufacturers. His headquarters will be at the Pittsburgh office in the Rea Building, 704 Second Avenue. Cowan has been with the Macwhyte Company for 13 years in various sales capacities.

Jack Long, sales engineer for Oil Base, Inc., has returned to the head office at Compton, California, after five months in Venezuela. While there,

Jack Long

he supervised the use of Black Magic oil base drilling fluid during drilling operations in various fields throughout Eastern and Western Venezuela.

John Van Norden, secretary and sales promotion manager of American Meter Company, Inc., died on March 17 at New York Hospital. He was a member of the executive board and the executive committee of the American Gas Association; treasurer and director of Gas Appliance Manufacturers Association, Inc.; a founder-member of the Society of Gas Operators, and clerk of the Gild of Ancient Supplers.

Vice Admiral Earle W. Mills, U. S. Navy (Retired) was elected president and chairman of the board of Foster Wheeler Corporation (New York). Admiral Mills joined Foster Wheeler Corporation early last year on his retirement from the Navy Department as Chief of the Bureau of Ships and was elected president of the corporation about six weeks ago following the death of Harry S. Brown.

David McCullough who has served the corporation and its predecessors since 1906, and who was recently appointed chairman of the board, has retired from active service and was elected vice chairman of the board. **Geoffrey H. Hopewell,** managing director of Foster Wheeler Limited, a British subsidiary, was elected vice president. **George Macnoe** president of Foster Wheeler Limited (Canada), was elected a director.

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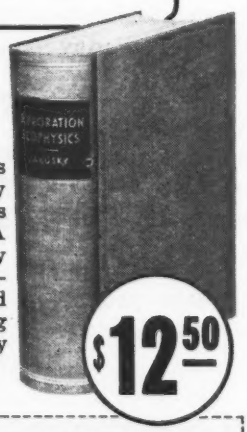
Modern Geophysical Techniques

EXPLORATION GEOPHYSICS

by J. J. Jakosky, Sc. D.



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Thirteen fact-packed chapters fully cover all contemporary methods; plus permit, trespass and insurance problems. A basic textbook for every geologist, geophysicist, engineer and physicist concerned with exploration, well logging and production. Adopted by many leading universities.

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TRIJA PUBLISHING COMPANY, TRIJA BUILDING, LOS ANGELES 24, CALIFORNIA

Harold H. Smith

C. B. Truitt

Harold H. Smith has been appointed advertising manager of the H. C. Smith Oil Tool Company. Smith has been active in the company as a sales representative for the past five years. For the last year, he has been assistant to the general sales manager.

Charles B. (Ike) Truitt has been appointed Southwestern division sales manager for the Grove Regulator Company, and will make his headquarters at the company's Southwestern division offices in Houston, Texas. He is a graduate of the University of Oklahoma.

David C. Neely, field engineer for Spang-Chalfant division of The National Supply Company at Houston, Texas, has been transferred to the field engineering department at Tulsa, Oklahoma. **C. C. Brush,** sales representative, Houston, has moved to the field engineering department at the same location.

Neely joined Spang-Chalfant in 1934 in the Ambridge, Pennsylvania plant. After 3 years he was transferred to Houston as field representative and later made field engineer. Brush joined the company in 1925 and has been a sales representative in Houston since 1933.

Fred B. Croner was promoted to a vice presidency of the company, in charge of procurement of Marmon-Herrington Company, Inc. For the past three years Croner has been responsible for the company's purchases of material and supplies. Previous to that time he was for 16 years with the Chevrolet commercial body division as general superintendent of material and production control.

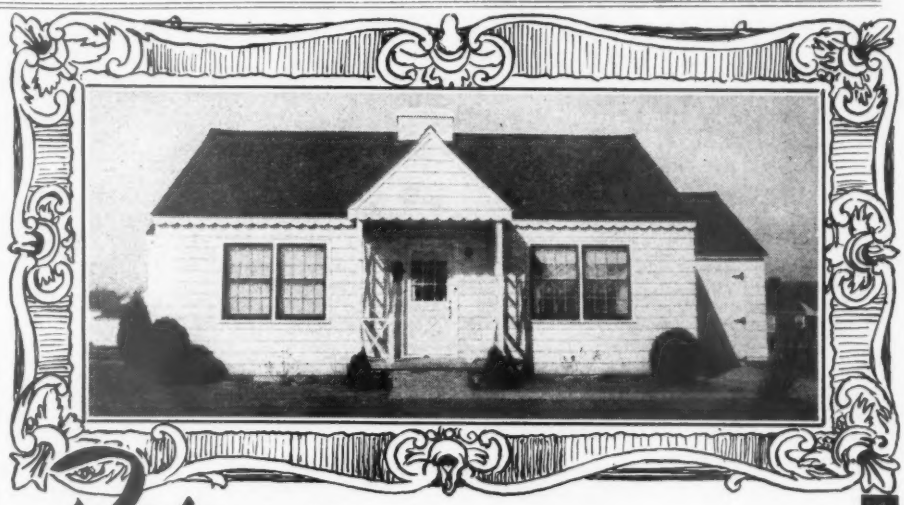
George H. Freers widely known automotive engineer and former chairman of the Indiana section of the Society of Automotive Engineers has been promoted by the directors of the Marmon-Herrington Company, Inc. to vice-president in charge of engineering. For the past 10 years, including the period of the company's complete conversion to the manufacture of military vehicles during the war, Freers has held the position of chief engineer.

Robert A. Seale has been appointed manager of the Shreveport, Louisiana, district for The National Supply Company. Seale has been engaged in oil industry work in the Shreveport territory since 1934, and was branch manager for Hughes Tool Company at Shreveport for 12 years prior to joining National Supply.

Seale succeeds **M. R. Brinkerhoff,** district manager at Shreveport for the past 10 years, who was recently appointed assistant division credit manager for the territory comprising Louisiana, Mississippi, Alabama, east Texas, and southern Arkansas.

H. R. Condon has been appointed vice president and general manager of the wood preserving division of Koppers Company, Inc. Condon, who has been a vice president in the division since 1929, succeeds **W. F. Munnikhuysen,** who has just been appointed executive vice president of the company. In 1929 Condon joined Century Wood Preserving Company, which later merged with Koppers.

R. R. Holmes, assistant general manager of the company's tar products division, was appointed vice president in that division. He joined Koppers Company in 1923.



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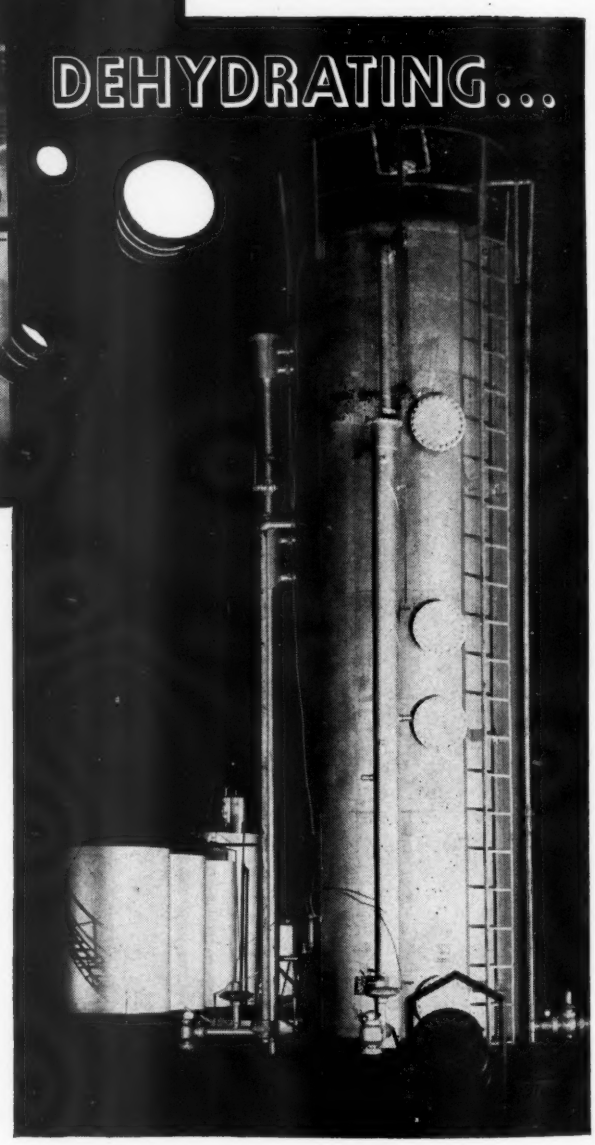

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new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE Petroleum Engineer
Irwin-Keasler Building
Dallas 1, Texas

(1) Tractor Shovel

The Frank G. Hough Company, 864 Sunnyside Avenue, Libertyville, Illinois, has developed a new ½-yd bucket capacity Payloader tractor shovel. According to the manufacturer, Model HE will dig, load trucks, grade, level, backfill, spread, and transport, as well as handle and rehandle bulk materials both inside and outside at the industrial plant.

Like other Payloaders, the Model HE is a complete Hough-built tractor-with-shovel, expressly designed for tractor shovel work. It has a full-reversing transmission with four forward and four faster reverse speeds with forward-reverse control separate from the regular gear shift.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 1.

(2) Pumping Units

Bethlehem Supply Company, 21 East Second Street, Tulsa, Oklahoma, has announced development of its Series 50 pumping units, which are equipped with a new adjustable counterbalance crank. The new adjustable counterbalance in the Series 50 units is both safe and fast, the manufacturer claims, allowing one man on the ground, with one wrench, at one setting of the cranks, to adjust all four weights in a matter of minutes. This is made possible by a new crank that incorporates cast gear racks, and by movable weights with gear pinions.

The Series "50" line is available in all API sizes ranging from 40,000 in.-lb to 320,000 in.-lb torque rated reducers, which are fitted to structures with API ratings of 9000 lb to 29,000 lb, and with reducer sub-base optional.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 2.

(3) Pipe Coating

Plastic Engineering and Sales Corporation, P. O. Box 1037, Fort Worth, Texas, has announced availability of Bauer and Black's Polyken tape as a complete pipe coating. The manufacturer states that Polyken is an oriented polyethylene film with a synthetic adhesive applied to one side. By virtue of its elasticity resulting from a unique cold working process, the material maintains a permanent pressure against the metal protected. Hence, moisture is prevented from flowing between tape and protected metal.

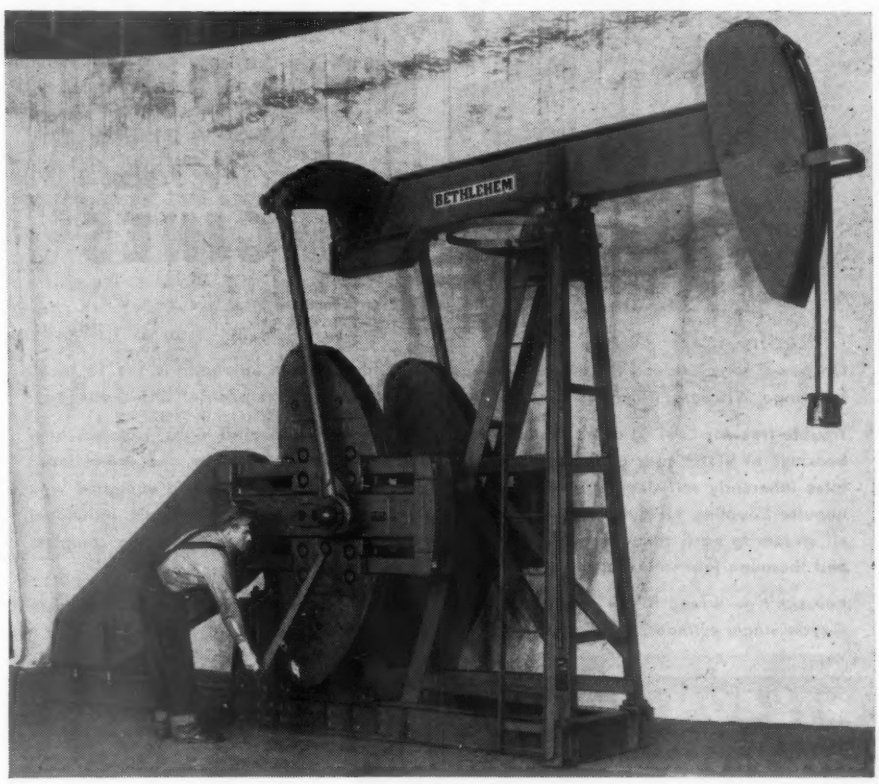
When writing company for additional information, refer to *The Petroleum Engineer* Item No. 3.

(4) Pre-Measured Rope

The New Bedford Cordage Company, Ash Street, New Bedford, Massachusetts, is now offering to the public pre-measured rope — factory marked in red at 10 ft intervals. The company states that pre-measured rope automatically protects the purchaser from brand substitution, as the red markings readily identify the manufacturer.

The rope is packaged in a self-contained colorful attractive carton on which the size, weight, and brand are marked. The container is dust-proof.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 4.



Bethlehem Supply's Series 50 pumping unit.

(5) Swivel Fittings

The Rasmussen Manufacturing Company, 12317 Industrial Avenue, Hollydale, California, has put on the market the Ramsco ball bearing swivel fittings. The fittings are made of the three following types: High pressure—up to 15,000 psi at 225 deg; for pressure or vacuum lines. Low pressure—up to 1000 psi at 225 deg. High temperature-corrosive service—up to 1000 psi at 750 deg. For steam, hot oil, or asphalt, butane-propane or other liquefied gases.

The fittings are made in single, double, and triple swing combinations, and can be adapted to any particular piping situation that requires a flexible steel swing line, regardless of whether the required movement is occasional or constant, whether it be the elimination of vibration or complete 360-deg turning.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 5.

(6) Tubing Spider

Advance Oil Tool Company, 2315 Carroll Park South, Long Beach 14, California, has announced manufacture of an air powered tubing spider, which, the manufacturer believes is the first practical device of its kind available to the trade.

Many advantages relating to safety are to be had from this device, the manufacturer states. It is impossible to drop a string tubing when the slips are in position against the tubing, as the pressure exerted causes the slips to ride the pipe at all times. The inconveniences and hazards in pulling a "wet job" are minimized as the control valve is remote and the action of the slips is automatic and positive when the valve is worked.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 6.

(7) Drop Hook

A new safety drop hook, capable of lifting, hauling, and easily releasing any weight is the latest invention of the Coffing Hoist Company, Danville, Illinois. The Coffing safety drop hook is a mechanical type using toggle action. On the model now in production, a 6000-lb model, just a 40-lb pull on the release lever will release a three ton load. When released, the jaws automatically remain open.

The side plates of the hook are made of special aluminum alloy and the load bearing hook, the internal cams and levers are of high tensile steel.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 7.

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15 TO 30 H.P.
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WISCONSIN
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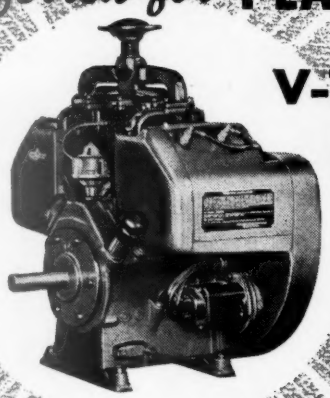

Model VE-4, V-type 4-cylinder standard engine 27.5 hp. at 2400 rpm.

On power jobs that call for rugged serviceability and sustained operation in the 15 to 30 hp. range, Wisconsin 4-cylinder engines rate *first preference* on the basis of such features as:

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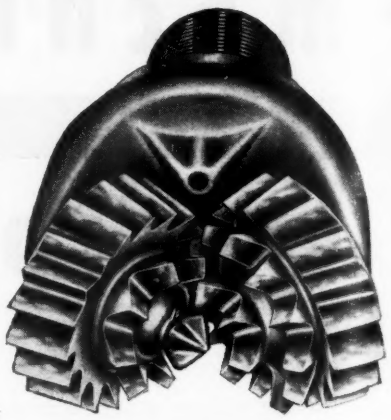
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

(8) Rock Bit

H. C. Smith Oil Tool Company has introduced its new two-cone rock bit. One of the principal features of this



new bit is its extremely effective circulation, with twin jets properly positioned to agitate and assure fast removal of the cuttings, and prevent balling-up of the cutter teeth.

The construction of this new two-cone bit follows that of all other H. C. Smith rock bits—triple bearing construction of the cones—ball thrust and roller annular bearings for longer wear and to maintain accurate gauge and straight hole. The single-piece alloy steel body is heat-treated for maximum strength. The teeth are hard-surfaced with tungsten carbide for maximum service life.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 8.

(9) Speed Control

A new speed control recently developed by Allis-Chalmers, Milwaukee, Wisconsin, for applications requiring frequent speed changes or for making adjustments without shutting down the drive, is now being employed on testing units in the oil industry.

The combination consists of a Vari-Pitch automatic sheave, companion sheave, wide-range Texrope belts, and Texslide motor base. The new sheave utilizes the Vari-Pitch sheave principle of moving angular faced discs toward or away from each other, thereby changing the pitch diameter of the sheave as desired. An automatic belt tension stabilizer provides the proper sidewall pressure and belt tension regardless of the position of the belt in the groove.

The new sheave has been developed and standardized to accommodate standard motors from 1½ to 40 hp with motor speeds from 900 to 1800 rpm.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 9.

(10) Generators

D. W. Onan and Sons, Inc., Minneapolis, Minnesota, has announced its new "Tractor - Drive" generators, available in 3000, 5000, and 10,000-watt capacities. The new generators supply exactly the same 115/230-v, 60-cycle alternating current delivered by the commercial power lines, the manufacturer states.

A feature of this new type generator is the mounted control box, with convenient knockout plugs, containing an a-c voltmeter that permits the generator speed to be adjusted to correct voltage, and a protective circuit breaker to guard against overloads.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 10.

(11) Speed Reducers

De Laval Steam Turbine Company, Trenton 2, New Jersey, has announced a new line of heavy-duty herringbone gear speed reducers. These IMO-De Laval reducers are available in single, triple and double reduction units of from ½ to 1000 hp, with center distances from 4 to 36 in. The gears are made of electric steel castings of high carbon steel forgings. Pinions and pinion shafts are cut integrally from heat treated chromemolybdenum steel.

Conveyors, generators, blowers, pumps, cranes, etc., can be powered through IMO-De Laval herringbone gear speed reducers.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 11.

(12) Hand Hoists

Wright Hoist Division of American Chain and Cable Company, Inc., York, Pennsylvania, has announced a new line of Wright Safeway hand hoists. These new Wright Safeway hoists are made in capacities from ½ ton to 4 tons. Their construction features simplicity of design, a modern gear drive, Weston type brake, steel load chain, steel housing, self - lubrication, and drop forged top and bottom hooks. Wright Safeway hand hoists have a high safety factor against possible impact loadings. Their portability, combined with an increased strength, makes them adaptable for many uses, according to the manufacturer.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 12.

(13) Flow Meters

A new line of mercury manometer flow meters has been announced by the Fischer and Porter Company, Hatboro, Pennsylvania. These flow meters require no pressure-tight bearings or stuffing boxes. They use the F&P magnetic clutch, or the F&P impedance bridge electric transmitter, which has three times the power of previous similar devices, the manufacturer states.

The F&P manometer flow meters are available in several models: Close-coupled magnetic clutch, with or without pneumatic transmission to a remote location — electric impedance bridge transmitter when it is desired to transmit to a distant exhibiting instrument—automatic control of the ratio of flow rate of two fluids.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 13.

(14) Weld Pipe

The Youngstown Sheet and Tube Company, Youngstown 1, Ohio, has developed and is offering for sale Yoloy weld pipe. Yoloy steel has been manufactured as seamless pipe, sheets, plates, and structural members for several years, and Youngstown is now using the same nickel-copper low-alloy steel as continuous weld pipe.

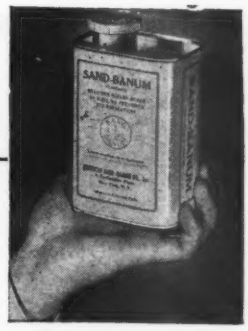
According to the manufacturer, Yoloy has an atmospheric corrosion resistance from four to six times that of regular carbon steels. Its resistance to shock and vibration is high, it bends and fabricates readily, its tensile strength is high, and it is high in corrosion resistance — these are all features of the Yoloy continuous weld pipe, the company claims.

When writing the company for additional information, refer to *The Petroleum Engineer* Item No. 14.

(15) Glass Pipe and Fittings

Glass pipe and fittings in ¼ through ¾-in. sizes are illustrated and described in a new catalog just published by Fischer and Porter Company, Hatboro, Pennsylvania. Also included is complete information on a recently-introduced metal-to-glass and glass-to-glass pipe coupling available in ¼ through 1-in. sizes, which replaces three - bolt triangular metal flanges and other devices. Easy to assemble, it greatly simplifies the installation and maintenance of glass piping. Perfect alignment is assured and even take-up gives freedom from breakage. Installation time is reduced, sometimes as much as 60 per cent.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 15.



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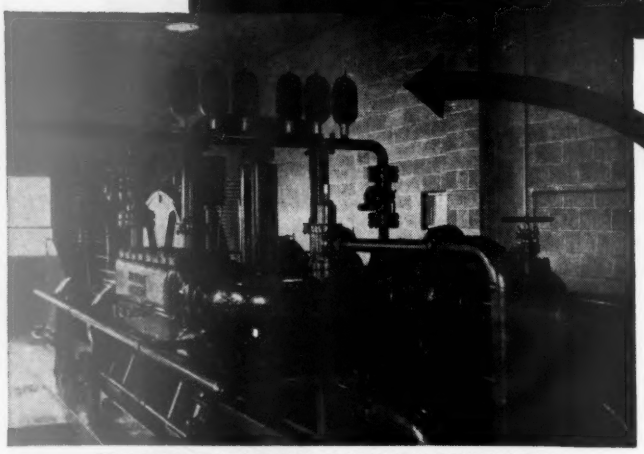


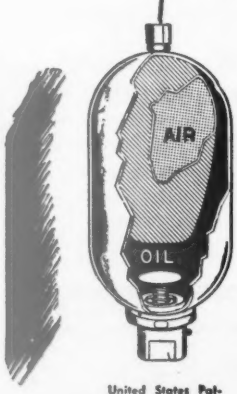
PHOTO COURTESY OF THE PORTLAND PIPELINE CORPORATION
335 FOREST AVENUE, PORTLAND 3, MAINE

PRESSURE surges caused by the pulsating action of piston pumps are the most common causes of pipe line and hydraulic system failures. Oil men in all phases of the petroleum industry have been cognizant of the hazards of pump pulsations but have had to live with that which was considered a necessary evil. This, however, is no longer true because an inexpensive GREER Accumulator installed in the discharge line of the pump will greatly minimize pressure surges by absorbing pump pulsations.

Actual tests on a series of ten pumps were recently conducted at the Portland Pipeline Corporation. A Hydrauliscope and camera attachment were used to measure and photograph the pressure surges before and after the installation of GREER Accumulators. The amazing results showed that the accumulators reduced these surges by 53% to 67%.

Our Engineering Department will be happy to demonstrate by similar tests in your own system the effectiveness of GREER Accumulators. Write for additional details using your company letterhead.

Our Bulletin 500 gives complete details on the elimination of pump pulsations. Write for your copy today.



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(16) Sight Feeds

McCord Corporation, Detroit 11, Michigan, announces a new development in visible sight feeds for force feed lubricator use. It may be cleaned without removing from the pump or disconnecting it from the oil line. The new sight feed carries a greater supply of liquid, consequently requires cleaning less frequently. The improved sight feed is now used as equipment on all McCord "SF" lubricators; it may also be used as a replacement unit. A specially processed Pyrex glass tube can be supplied on request for use with high pressure lubrication applications. With this tube oil can be fed against pressures in excess of 4000 lb, according to McCord Corporation.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 16.

(17) Portable Plant

Designed for applications needing a portable source of electric power, a new 400-watt, 60-cycle, a-c electric generating plant that will operate for five hours on a single gallon of gasoline has been developed by D. W. Onan & Sons Inc., Minneapolis, Minnesota. Nineteen inches long, with a width of 14¼ in. and a height of 16¼ in., this generating plant produces power for amateur radio operations, emergency floodlights, public address systems, sound recorders, and geophysical instruments.

These new units are available in either portable manual or remote starting models.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 17.

(18) Breather, Drain Valves

New Type "R" breather and drain valves manufactured by Russell & Stoll Company, Inc., New York, New York, are made of tensile aluminum alloy with anodized finish. This alloy permits their use with either iron or aluminum enclosures without deleterious effects of electrolysis usually experienced when the conventional breathers and drains of brass are threaded to aluminum enclosures, the manufacturer has announced.

Breather and drain valves are recommended by the company for use in conjunction with conduits and enclosures that form parts of a system exposed to weather or warm moist atmospheres. They prevent all troublesome quantities of water caused by condensation in conduit systems or enclosures, and inferior conduit connections. When writing company for additional information, refer to *The Petroleum Engineer* Item No. 18.

(19) Alarm Signals

Panalarm Products, Inc., 7218 North Clark Street, Chicago, Illinois, has announced its new alarm signals. Series 400 units have hermetically-sealed relays on a sealed plug-in octal socket for alarm signaling systems in hazardous locations and corrosive atmospheres.

Operation of the new Series 400 is similar to that of Series 300 Panalarms. Many combinations of light and sound signals are available to warn of abnormal operating conditions. Applications of Panalarms can be made wherever desired for monitoring speeds, time cycles, pressures, temperatures, liquid or gas flow, or electrical or mechanical equipment operation.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 19.

(20) Cylindrical Valve

A non-lubricating cylindrical plug industrial control valve, providing leak-proof shut-off while eliminating contamination, has been developed by Minneapolis-Honeywell Regulator Company, 2743-53 Fourth Avenue South, New York 16, New York. The new design includes a permanent seal at the plug stem, sealing packing at the base of the plug, and a fixed-load spring, combined with a closer dimensional tolerance and micro-finish.

Torque tests show that the cylindrical valve's greatest torque requirement, about 250 lb per in. at a line pressure of 250 psi, was equivalent to a force of only 12½ lb acting on a lever arm 20 in. long.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 20.

(21) Casing Adjuster

The Creighton Oil Tool Company, P. O. Box 4133, Long Beach 4, California, has announced development of a new casing adjuster. The Creighton adjuster consists of two basic units. One unit is an inner mandrel and clutch assembly, and the other unit is the outer body, which contains a packing assembly and integral clutches that engage with a companion mandrel clutch at each end of the stroke.

The manufacturer claims that the casing adjuster functions as an elastic member by adjusting the casing or liner to compensate for any lateral or vertical movements of the earth. Depending on the earth's movements, the casing adjuster automatically expands or contracts.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 21.

YOU get 30% more strength when you use TM Alloy Steel Spinning Chain. It's tougher and much harder than conventional types. Shorter links assure better grips and complete heat-treatment in modern furnaces means uniformity in every link. Insist on TM Alloy Spinning Chain for longer chain life — *even in today's deep wells.* Also available in TM Hi-Test Grade. See your nearest oil well supply store for details on these and other TM Chains for hold-downs, snake-ins, rigging and the complete line of TM Truck and Passenger Car Tire Chains.

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A GREAT NAME IN
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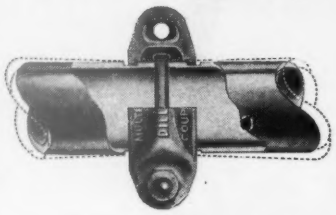
DILLON
flexible-locked
COUPLINGS



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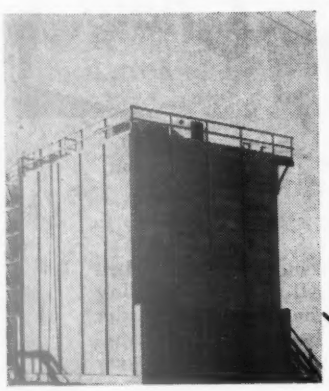

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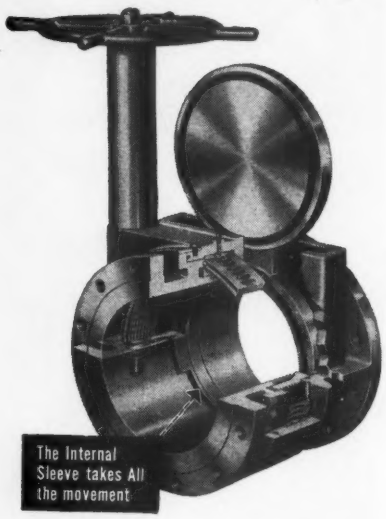
(22) Line Valve

Hamer Oil Tool Company, 2919 Gardenia Avenue, Long Beach, California, has announced its new "Rigid" line blind valve, which utilizes an internal sliding sleeve to seal against and release the spectacle plate without movement or expansion of the pipe line. The sleeve is moved against or away from the plate by means of a ball bearing mounted ring gear actuated by turning the hand wheel. Operation is not affected by misalignment or expansion and contraction of the pipe line. Operator can reverse the spectacle plate in less than a minute.



The Internal Sleeve takes All the movement

Rigid line blind valves made of steel are available in ASA 150 lb and 300 lb classes in sizes from 6 to 12 in. Spectacle plate packing rings are available in a variety of materials to meet service requirements.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 22.

(23) Gland Ring

By using a positioner mounted on a quick-acting elevator, a gland ring was welded, top and bottom, to a pump liner shell without removing it from the positioner and without changing the level of the "Unionmelt" welding head. The fixture, consisting of a standard welding positioner mounted on an air piston, was designed and built for their own use by Gardner Denver Company, Quincy, Illinois.

The pump liner assembly is a tubular shell with a fairly thick ring pressed onto one end. The shells are made of alloy steel tube, 8¾ in. in diameter and 26 in. in length. The gland ring, 1½ in. wide and about ⅞ in. thick, is welded to the shell about 2 in. back from one end. The inner edges of the ring are machined to provide welding vees on top and bottom. Each weld is about 28 in. in length and is made by the "Unionmelt" welding machine in 2½ min.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 23.

(24) Shovel-Crane

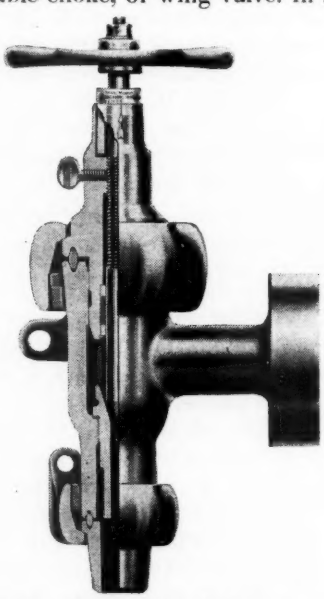
The Lorain-50 is a new power shovel-crane introduced recently by The Thew Shovel Company, Lorain, Ohio. This new machine is rated in the one yard class and is claimed by the manufacturer to be the first machine in this class equipped with a hydraulic coupling as standard equipment.

The power take-off on the Lorain-50 is by means of a Twin-Disc hydraulic coupling. The manufacturer states this device prevents stalling the engine due to any digging circumstances and provides a means of absorbing digging stresses and strains before they are transferred into the operating mechanism and the cables. The hydraulic coupling is equipped with a plate clutch "de-clutcher" to permit stopping the machinery without stopping the engine.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 24.

(25) Wing Valve

Thornhill-Craver Company, Houston, Texas, has announced a new adjustable choke, or wing valve. In new Unibolt adjustable choke, or wing valve, according to the announcement, the stem packing is arranged to eliminate the need for further tightening after the valve is assembled at the factory. Adequate sealing compression is applied to the packing to assure a pressure-tight seal yet permit the stem to turn freely in the packing.



When writing company for additional information, refer to *The Petroleum Engineer* Item No. 25.

trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(26) Engineering Data

Hammel-Dahl Company, 243 Richmond Street, Providence 3, Rhode Island, has issued a new 20-page bulletin titled, *Hammel-Dahl Engineering Data Bulletin*. Included in the bulletin are network sizing charts used to determine the correct size of Hammel-Dahl valves for liquid, steam, or gas service. As all Hammel-Dahl single-seated valves have the same capacity as the equivalent size double-seated valves, the charts can be used for both single and double-seated valves of any body rating, 125-lb ASA standard cast iron to 1500-lb ASA standard cast steel.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 26.

(27) Fatty Acid

A new 24-page fatty acid specification catalog has just been made available by W. C. Hardesty Company, Inc., 41 East 42nd Street, New York 17, N. Y. The catalog lists complete specifications and shipping data on a complete line of fatty acids, which include stearic acid, red oil, animal and vegetable and fish oil fatty acid, stearine pitch, and glycerine. Also included are three data charts showing composition of fats and oils, color standards comparator and temperature conversion tables.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 27.

(28) Safety Heads

"BS&B Safety Head Price List" is a 16-page illustrated bulletin explaining sizes, ratings, specifications, and prices of Black, Sivalls and Bryson, Inc.'s safety heads and accessories. Covered in the booklet are safety head flanges, safety head rupture discs, safety head vacuum supports, refrigerant relief valves, pressure-vacuum vent valves, and combined vent valve-flame arrestor units. Copies may be obtained from the company, 720 Delaware, Kansas City, Missouri.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 28.

(29) Oil and Gas Separators

Three bulletins have been published recently by Peerless Manufacturing Company, P.O. Box 7193, Dallas, Texas.

Bulletin 201, a 4-page, 2-color, folder featuring Peerless oil and gas separators, is now available. This fully illustrated folder explains entrainment, foaming, fabrication of Peerless separators, and special design separators to meet specific needs.

Bulletin 203, four pages in two colors, features Peerless high pressure oil and gas separators. This folder is illustrated with photographs and cross sectional drawings and contains specifications of high pressure separators as well as oil capacity tables and gas capacity tables.

Bulletin 204, Peerless high-surface horizontal separators, discusses the Peerless solution to the problem of the separation of foaming crude oil and the separation of oil at high pressures.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 29.

(30) Drill Bits

A new illustrated 12-page catalog of interest to those engaged in slim-hole production drilling, exploration drilling, water-well and mining operations, has been announced by Herb J. Hawthorne, Inc., P.O. Box 7299, Houston, Texas, manufacturers of Hawthorne "Blue Demon" bits.

Publication of the catalog occurs almost simultaneously with an announcement of increase in size range of the Hawthorne standard line of exploration drill bits. The new sizes—which bring the range from 1⅞ to 8 in.—are featured in the catalog.

In addition to descriptions and specifications of all Hawthorne replaceable blade drill bits, the catalog discusses results of comparative tests made between roller-type bits, drag bits, and Hawthorne bits in various formations.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 30.

(31) Coated Fabrics

Vulcan Proofing Company, 58th Street and First Avenue, Brooklyn, New York, makers of rubber and synthetic rubber coated fabrics for industrial uses, has issued a new catalog detailing a wide range of such fabrics and featuring many new fabrics and new coatings. The list shows detailed specifications, including 10 variations under premier coatings, a wide choice of neoprene coated fabrics, coated fiberglas, Buna-N coatings on nylon and cotton fabrics, natural rubber coatings, special coatings for automotive uses, such as fuel pumps, vacuum pumps, and other components.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 31.

(32) Steam-Jet Deaerators

Worthington Pump and Machinery Corporation, Harrison, New Jersey, has published a new bulletin, W-210-B29, on its steam-jet deaerators. The Worthington deaerator, the manufacturer has stated, is suitable for application in almost any power plant where the ultimate in deaeration is a major consideration.

The steam-jet deaerator is fully illustrated in the company's 8-page folder, and construction and operating features are listed. Worthington's deaerating heaters and deaerators may be furnished for pressure, vacuum, or pressure-vacuum service, with any required amount of water storage.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 32.

(33) Aluminum Stearate

Witco Chemical Company, 295 Madison Avenue, New York, N. Y., has issued a new technical service report, M-5, entitled "Aluminum Stearate for the Grease Industry". The report describes five grades of aluminum stearate, which will help the grease maker to select the type most suitable for use in the oil and equipment he has available in his plant.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 33.

(34) Fire Inspection Chart

Ansul Chemical Company, Marinette, Wisconsin, has designed a periodic inspection chart that helps fire inspectors keep accurate records of their extinguishers. Space for 26 inspections of up to 38 extinguishers is provided. Available upon request.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 34.

(35) Valve-Sizing Charts

Liquid and gas valve-sizing charts, covering the ranges 0.02 to 10,000 gal per minute and 1 to 100,000 lb per hour respectively, have just been published by Fischer and Porter Company, Hatboro, Pennsylvania.

The liquid valve-sizing chart takes into account the difference between pressure drop across the valve and across the valve ports alone, liquid viscosity and specific gravity in determining port area and valve size. The gas valve-sizing chart takes into account inlet and outlet absolute pressures, gas specific gravity, and temperature.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 35.

(36) Meter

A four-page pamphlet in color recently issued by Flow Equipment Company describes in detail the G-Whiz Meter, a fluid measurement instrument so simple in design that one maintenance man can look after several hundred of them in a single field. They have one moving part only and as the inside of the meter is hard chromed, wear is cut to a minimum.

The metal parts of the rotor are corrosion resistant and the rotor blades are of material that is unaffected by oil. These meters will handle from 200 to 1000 bbl a day at a working pressure up to 500 psi, and, having a full bore through the meter case, have no tendency to stick when foreign substances pass through.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 36.

(37) Bulletins Available

%Proportioneers, Inc.,% P.O. Box 1442, Providence 1, Rhode Island, has released a 6-page bulletin listing bulletins available from the company dealing with constant rate and flow responsive chemical proportioning. The folder contains listings of the following: General bulletins, standard methods, reprints, and instruction books.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 37.

(38) Swivel Bails

A new connector-type swivel bail, available for all Ideal swivels and designed to effectively contribute to greater drilling efficiency is described in the new 8-page Bulletin I-363, just issued by and procurable upon application to The National Supply Company, P.O. Box 899-A, Toledo, Ohio. Construction features of the connector-type bails are described in the bulletin, which also carries photographs showing the simplicity of construction, and ease of handling, of the new piece of equipment.

Ideal connectors and the new connector-type swivel bail eliminates use of the hanging elevator on the old style hook, as well as link bumper supports on the swivel, the manufacturer claims.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 38.

(39) Metallurgical Bulletin

Hunt-Spiller Manufacturing Corporation now has available a new edition of its metallurgical bulletin. This bulletin was developed by the metallurgical department at Hunt-Spiller to aid the user of industrial castings in the selection of proper metals and alloys. Complete physical and chemical properties, general descriptions, metallographical plates, suggested applications, and other important information is included on a number of metals.

Copies of the metallurgical bulletin may be obtained by writing on company letterhead to Hunt-Spiller, 383 Dorchester Avenue, South Boston 27, Massachusetts.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 39.

(40) Safety Devices

The Pelton Water Wheel Company, 2929 19th Street, San Francisco 10, California, has issued a new letter describing its hydraulic pumping jack safety devices. Four safety devices are installed on each unit: A main pump relief valve, to protect against overloading pressures; a thermal switch, as protection against over-heating; a shut-off valve and limit switch; and an operating oil low pressure switch, which is wired to ground out the ignition system of the prime mover when the balance tank pressure falls below a minimum pressure.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 40.

(41) Chemical Feeders

Black, Sivalls and Bryson, Inc.'s, 720 Delaware, Kansas City, Missouri, new 14-page issue, Catalog 54 is now available. The illustrated bulletin describes in detail the company's new chemical feeders. Included are the special features of the feeder, which operates on compressd air or gas at 25 to 1000 psi. A diagram portrays the process through which the feeder goes. Copies are available on request.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 41.

(42) Drive Groups

The National Supply Company, Box 889A, Toledo, Ohio, has announced a new 12-page, two color, illustrated bulletin on Ideal Type "BL" sectional drive groups for Type 50 rigs.

Bulletin I-362 covers two and three-section type "BL" drive groups that have airflex engine and pump drive clutches and air actuated engine throttles that can be remotely controlled from the driller's position. The bulletin includes, in addition to photographs of two and three-section drive groups in various stages of completion, dimensions and specifications, and dimensional layouts with a listing of applicable engines.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 42.

(43) Sump and Cycling Pumps

Two new bulletins have been released by Penberthy Injector Company, 1242 Holden Avenue, Detroit, Michigan. The 2-page bulletin deals with Penberthy's automatic electric sump pumps, which are made in five sizes for different sump depths, and constructed of copper and bronze throughout. Series MC Penberthy sump pumps have totally enclosed and explosion-proof motor and switch, and have underwriters' approval for hazardous locations.

Penberthy's cycling jet pumps is the subject of the 4-page bulletin. This pump may be operated by air, gas, or steam pressure, pumps any liquid, and, as it is automatic, requires no attention. In a typical operation, this pump will discharge 1380 gal per hour against 30 psi discharge pressure with a gas, steam, or air consumption of 24 to 30 cu ft per min.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 43.

(44) Arc Welding

A new folder describing the main features and specifications of Heliarc apparatus now available, has recently been published by The Linde Air Products Company, 30 East 42nd Street, New York, N.Y. Equipment illustrated includes the following: Five models of the torch for manual and mechanized operation, new argon regulator and argon flowmeter, especially designed to give accurate gas flows, ceramic and water-cooled shielding-gas cups, and electrodes.

Advantages of the inert gas-shielded arc welding process and the metals for which it can be used are described as well as the theory of the process.

When writing company for additional information, refer to *The Petroleum Engineer* Item No. 44.

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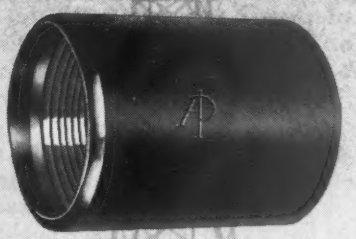

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▸ **Worlds in Collision,** *by Immanuel Velikovsky, The MacMillan Company, New York City, New York. Pages, 401. Price, $4.50.*

Immanuel Velikovsky, born in Vitebsk, Russia, in 1895, conceived the idea for this book in 1940. In research for other books he had become steeped in Egyptian history, Greek legends, and the Jewish past. The volume is an attempt to reconcile the world's heritage of record and advance theories to fit the documentary evidence.

Worlds in Collision deals with the planets of our solar system, and by citing forgotten incidents, Velikovsky infers that the planets may not be as fixed in the solar system as the human race has always believed them to be. Velikovsky contends that more than once within historic times they ran amok and caused enormous cataclysms; the earth became a primeval chaos lashed by tornadoes of cinders; the skies darkened; land masses were destroyed; and large portions of the human race perished.

The volume is of universal interest and written simply for wide understanding. The idea of the change in the magnetic poles of the earth and other theories along this line are of particular interest to the geologist.

▸ **Summary of Secondary Recovery Production Statistics and Estimated Water-Flood Reserves, Kansas, 1948,** *compiled by Albert E. Sweeney, Jr., Interstate Oil Compact Commission, P. O. Box 3127, State Capitol, Oklahoma City 5, Oklahoma. Pages, 62.*

This bulletin was a joint project between agencies of Kansas and the Interstate Oil Compact Commission. The report contains a history of production from Eastern Kansas Counties as well as statistics on production from all Kansas counties. In addition, tables summarizing the secondary recovery data on various Kansas counties are included. The production histories are presented graphically and nine maps of the producing areas of Eastern Kansas are included.

▸ **Earth Waves,** *by L. Don Leet, Harvard University Press, Cambridge, Massachusetts; New York: John Wiley and Sons, Inc. Pages, 122. Price, $3.*

This is a compact summary of present knowledge about waves in the earth. Wide application in such waves are found in the search for minerals, studying of hurricanes, measuring of vibrations from dynamite blasts to determine their effects on buildings, and the mapping of broad earth structures of geologic interest. Also included in the book titled *Earth Waves,* are the results of recent research, previously unpublished or available only in periodicals of limited circulation, presented on types of wave motion, interpretation or refraction profiles, and microseisms.

▸ **Statistics of Natural Gas Companies, 1948,** *compiled by the Federal Power Commission, Washington, 25, D. C. Pages, 608. Price, $2.*

Compilation of information taken from annual reports of natural gas companies to the Federal Power Commission for the year ended December 31, 1948. This book contains information on 121 gas companies, three of which merged during the year, leaving 118 companies operating at the end of 1948. Assets of the reporting companies as of that date aggregated $4,356,731,000. Composite statements of

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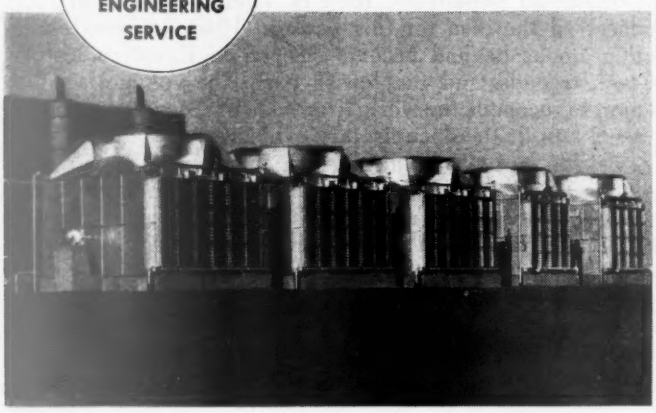

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the balance sheet, income account, operating revenues, customers and sales, operating expenses, and gas account for the year 1948 are also included. No attempt was made to consolidate the accounts of the companies included in the respective statements. The combined total represent merely the sum of all accounts as reported by the invidual companies.

▸ **Standards of Heat Exchange Institute, Method and Procedure for the Determination of Dissolved Oxygen,** *compiled and published by the Heat Exchange Institute, 90 West Street, New York 6, New York. Pages, 32. Price, $2.*

The direct contact heater section of Heat Exchange Institute has produced a standard for the measurement of dissolved oxygen in deaerated and partially deaerated waters, and published its findings in this 32-page booklet. According to the Institute, the method and procedure described in this Standard will produce accurate and reliable test results, even when employed for the analysis of water containing reasonable quantities of impurities.

▸ **Coal, Coke, and Coal Chemicals,** *by Philip J. Wilson, Jr., and Joseph H. Wells. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, New York. Pages, 509. Price, $8.*

A treatise on coal, high-temperature coking, recovery of coal chemicals from the coke-oven gas, and distillaton of tar, every phase of the industry, is systematically covered in this book. Fuels in general, and the principles of combustion receive some attention in the book, and the closing chapters are concerned with the economics of the industry. The book makes liberal use of photographs and diagrams. For further convenience to the reader, there is a bibliography of literature and a list of visual aids pertinent to the subject.

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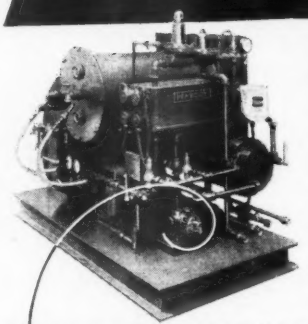

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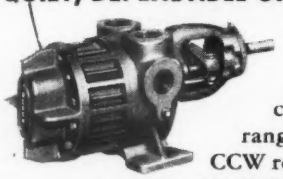

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